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ABSTRACT

The advantages of an interdisciplinary approach to college instruction and research are examined, based in part on a 1983 symposium of the European Centre for Higher Education. Six case studies are also presented. It is noted that interdisciplinarity opens up possibilities of exchange between individual disciplines and encourages the development of interdisciplinary methodological concepts and models of explication. Interdisciplinary research intensifies specialized research and offers models of synthesis that are of central importance not only to the sciences, but also to the development of practice-related orientations for action. Interdisciplinary research is also important in solving problems in society. The following practical cases of interdisciplinary study and research are described: The Norwegian Regional Colleges, the Danish Universities Centres, the Linkoping University, the Bielefeld Centre for Interdisciplinary Research (Western Germany), the University of Sussex, the University of Wisconsin at Green Bay, University of California at Santa Cruz, Evergreen State College, and the Pennsylvania State University. It is recommended that UNESCO disseminate information to promote adoption of interdisciplinary study and research. (SW)

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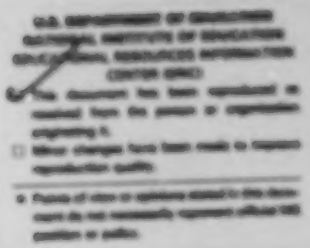
INTERDISCIPLINARITY IN HIGHER EDUCATION



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INTERDISCIPLINARITY IN HIGHER EDUCATION

A study established by Thor Einar HANISCH
following a symposium organized by the
European Centre for Higher Education
(Bucharest, 24-26 November 1983)

Bucharest

1983

FOREWORD

The European Centre for Higher Education (CEPES) organized in Bucharest, November 24-26, 1981, a symposium on "Interdisciplinarity in Higher Education in Europe".

Twelve experts from the Europe Region, invited by the Director General of Unesco in their personal capacity, participated in the meeting. Additionally, a number of observers and representatives of national and international bodies were present. CEPES prepared a "General Information Note" which presented the objectives of the meeting and gave a short introduction to the subject at hand. The note also outlined the many different types of interdisciplinarity. Furthermore, a Working Document prepared by the Secretariat and a Reference Document submitted by Prof. Nicolau served as bases for discussion. The participants contributed individual papers referring to particular experiences on a national or institutional level.

Interdisciplinarity appears as a major challenge for higher education in the future. While interdisciplinarity has been the object of epistemological debates for many decades, new practical experiences have been recently carried out in numerous countries. Therefore the symposium drew wide interest. Instead of a final report, it was decided to publish a more extensive document that would draw on the ideas presented at the symposium as well as the vast literature published recently on this issue. Thor-Einar Haniech who was the rapporteur of the meeting agreed to prepare this study which was subsequently edited by Wolfgang Vollmann.

We are honoured to present this work to our readers. We hope it will meet the widely expressed needs to review past and present discussions on interdisciplinarity, to highlight significant experiences on the issue, and to point out possible future developments. This study is also intended to assist in overcoming the often regretted lack of exchanges in this field.

The European Centre for Higher Education expresses its gratitude to the symposium participants, to the author of the study, and to all those who contributed to the realisation of this document.

FRANK EBERHARD
Director CEPES

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1. INTRODUCTION

In conformity with the wishes expressed by the Advisory Committee of the European Centre for Higher Education (CEPES/Unesco) at its Eighth Session (Bucharest, October, 1980), a symposium on Interdisciplinarity in Higher Education was organized at the Centre in Bucharest from November 24 to 26, 1981.

The contributions of the participants to the symposium coupled with the fruitful and active involvement of a corresponding number of observers and representatives of the CEPES resident staff (see annex 2) constitute the basis of this study. One of the participating observers was professor Edmond Nicolau of the Polytechnical Institute of Bucharest who prepared a valuable Reference Document. Mr. Audun Øfjord, Director of CEPES, was responsible for preparations which culminated in a most successful symposium at which professor W. Vosskamp (F.R.G.) as Chairman and professor L.A. Pronin (U.S.S.R.) as Vice-Chairman, with the author of the present study as Rapporteur, formed the elected bureau.

The point of departure for this study was the general consensus in the symposium that scientific, technological, and socio-economic development is continuously creating new demands for professional skills of interdisciplinary character. In general, it was felt that higher education institutions are not responding adequately to the new needs. Traditional institutions continue with a multidisciplinary pattern, and the introduction of interdisciplinary courses is sporadic and does not reflect the real change with respect to new requirements.

The participants recommended that, within the framework of the Organization's competence, mandate, and approved programme, Unesco and CEPES should promote interdisciplinary higher education and research, including the dissemination of information to the development of contemporary society.

To the Bucharest symposium it was also evident that specialized research and a monodisciplinary educational approach could, in special cases, be of great value. The present situation, however, is characterized by a severe lack of interdisciplinarity and one-sided specialization. It is important to have in mind that an interdisciplinary approach can also provide a vital stimulus to the disciplines. Therefore the promotion of the need does not necessarily mean a devaluation of the other. The Chairman of the Bucharest conference, professor Wilhelm Vosskamp, Managing Director of the Centre for Interdisciplinary Research, University of Bielefeld, may very well have struck the right balance with this formulation:

> "The development of science in recent years and decades has shown that a growing internal specialization of individual disciplines and the increasing differentiation of science in general requires an increasingly interdepartmental, interdisciplinary approach. Interdisciplinarity opens up possibilities of exchange between individual disciplines, but also lends more transparency to the connections between the disciplines and encourages the development of interdisciplinary methodological concepts and models of explication.

Interdisciplinary research thus both intensifies specialized research and offers models of synthesis which are of central importance not only to the sciences, but also to the development of practice-related orientations for action. Apart from the central role of interdisciplinary research in basic research, its importance in solving problems which arise from changes in the overall social framework are particularly noteworthy. The connection between interdisciplinary research and public life is thus self-evident."[1]

1. Wilhelm Vosskamp, "Interdisciplinary Research", paper read at the Bucharest Symposium, November, 1981.

2. THE CASE FOR INTERDISCIPLINARITY

As we shall see later, in chapter 3, interdisciplinarity is a term that is not easily defined theoretically; and in chapter 4 we learn that practical cases and applications are so far limited in scope but perhaps greater in impact. Before going into detail, it might seem appropriate to take an overview and place the broad concept of interdisciplinarity in both an historic and a current context. For this purpose the viewpoints published by George Gusdorf, professor Emeritus of the University of Strasbourg, in Unesco's International Social Science Journal (No. 4, 1977, a special issue on interdisciplinarity) have proved to be particularly helpful. Papers presented by professor Eviatar Nevo, Institute of Evolution, University of Haifa, at the Bucharest Symposium in November, 1981, and by professor Marcel Y. Fabri, Centre Démographique ONU (CEDOR) at the "Congrès Général de l'Union Internationale pour l'Etude Scientifique de la Population" in December, 1981, in Manila, are also valuable manifestations of Unesco's and the UN's increasing involvement in this significant field.

It is tempting to cite Marcel Y. Fabri's observation at the Manila conference as a statement to dispute or to confirm through the current Unesco study:

> L'interdisciplinarité présente plus d'un point commun avec les grands vieillards du Caucase: tout le monde en parle, personne ne les a vus, et il y a longtemps que cela dure.

Running the risk of jumping to premature conclusions, we may feel at first glance that this observation seems quite to the point. As we shall see in the selected case studies, however, the situation is not as pessimistic as all that. After all, the old people of Caucasus did and do exist, do they not? So does interdisciplinarity.

To the writer of this study, or rather, the compiler of important elements of a complex totality, it seems unrealistic to try to improve on presentations which have already been made in such an eminent way by the distinguished professors referred to above. Let us therefore draw heavily on them to get a much needed historical overview of the field:

First George Gusdorf, the author of Introduction aux Sciences Humaines (1960) and of Les Sciences Humaines et la Pensée Occidentale:

The need for interdisciplinarity has been reflected in epistemological writings ever since the origins of Western science. The Greek Sophists, the patriarchs of our own pedagogy, established a programme for an 'enkuklios paideia', a circular teaching by means of which the pupil surveyed in turn all the disciplines which went to make up the intellectual order. This encyclopaedic programme was taken over and developed by the Roman rhetoricians, who handed down the idea of the 'orbis doctrinae' to the masters of medieval learning. From the thirteenth century on, the university entrusted to its faculty of arts the management of the system which went to make up liberal arts, i.e. the branches of learning concerned with intellectual freedom. The 'trivium' (grammar, rhetoric and dialectic) combined with the 'quadrivium' (arithmetic, geometry, astronomy and music) to form a unified whole which included both letters and the sciences. This total pedagogy was maintained without interruption up to the Renaissance, when it continued in the form of traditional humanism, as for instance in the Jesuit Colleges, the abolition of which in the 1970's was a disaster in the field of education. The age-old programme of 'enkuklios paideia' was destroyed, but nothing was put in its place, and the subsequent cancerous proliferation of suggestions, schemes and experiments concerning the sort of knowledge to be transmitted from one generation to another reflects the disorientation of modern thought on the subject of intellectual training.

The medieval university aimed at being not only a community of teachers and students (universitas Magistrorum et scholarium) but also a community of disciplines of knowledge (universitas scientiarum); the integration of knowledge was the setting for the union of men. The dividing up and specialization of epistemology had to be compensated for: the centrifugal factor had to be balanced by a centripetal one in order to preserve mental space from disintegration. This kind of total pedagogy was strongly advocated by the naturalist Pliny, who died in the eruption of Vesuvius in A.D.79: "The power and majesty of nature in all its aspects is lost on him who contemplates it merely in the detail of its parts, and not as a whole". [1]

In 1844, Alexander von Humboldt used this quotation as an epigraph to his greatest work, Kosmos, an inspired attempt at interdisciplinary epistemology. In antiquity, the Museum at Alexandria, a centre of teaching and research, a university before its time, wielded enormous influence for more than five hundred years: it embodied, in the heart of the Hellenic world, the idea of a gathering together of sciences and letters, arts and techniques in one common centre where concentration of men and abundance of technological equipment would facilitate a common programme of cultural synthesis.

These time-honoured examples show that the idea of knowledge as one single realm is a constant factor in epistemology. The contemporary call for interdisciplinarity is only a reaffirmation of a lost wholeness; behind the idea of a future science better than

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1. Pliny, Historia Naturalis, vol. VII, Ch. 1.

> that of the present lies a longing for a lost past. From age to age, the idea of interdisciplinarity has been one of the guiding tendencies in the history of knowledge. As specialization has brought about the advancement of learning, so the concern for unity has fostered as desire for a bringing together again, a reamalgamation to remedy the intolerable fragmentation both of the fields of knowledge and of men of science.

George Gusdorf's historical examples of statements by great thinkers who had appreciation for interdisciplinarity represents a rich source of inspiration to a generation that needs to act on the challenge they represent.

Gusdorf blames Napoleon for his destructive division between the faculties of letters and science. But he also very appropriately cites M. Charles Dupuy, Chairman of the French Committee on Higher Education (Revue Internationale de l'enseignement, Vol. LXII, 1911, p. 259), who, frustrated, observed:

> The word university is only a word...because it does not refer to an organization in which the elements are all interdependent and the parts feel themselves to be organs of the same whole....Everyone follows his own bent; the man of law and the man of letters form groups apart, and in each of these faculties the specialists in different subjects form groups which are closed to, not to say jealous of, the others...At the moment specialization reigns supreme.

It is interesting to see that a Parlamentarian took this critical attitude toward the fragmentation and isolation of the universities in 1911, airing a view expressed often today. The willingness and ability of the institutions of higher learning to undergo change, even when change is urgently needed, did not and do not seem to impress anybody either inside or outside of the institutions themselves.

According to Gusdorf, the dissociation of knowledge is both cause and effect of the dissociation of human existence in the world today. 'The university crisis of 1968, was "a paroxysm of despair" which reflected the need for a reshaping of mental space as a whole. Among the confused demands of the "irate" students the notion of interdisciplinarity was often mentioned. Even before 1968, the German scheme at the University of Constance reflected the new desire to abolish the barriers and misunderstandings which separated and sometimes set in opposition the different areas of epistemological space, by bringing science and letters together in the training of the mind.

Was the 1968 student revolt "a desperate measure of defence" to preserve entire, or at least in part, the wholeness of the intellect? And was also this cry for change bound to succumb to the power of inertia mustered against innovation by traditional institutions?

Did the claims of the 1968 student generation share with those of almost every thinking human being today the insistence that focus should be put on problems that involve major decisions and are of vital political significance? Or, the burning problems of the world taken into consideration, is

it just too frustrating to remain for a long time in forums "where problems are studied but not decided upon?" If the answer to one or both of these questions is "Yes," the implementation of interdisciplinarity is also a vital endeavour that scholars and universities should no longer oppose!

Professor Eviatar Nevo, one of the participants of the CEPES Symposium, outlines in his paper "Interdisciplinarity: Theory and Practice" the need for a change in the philosophy and methodology of the educational system:

> The educational system needs a radical change in objectives, structure and methodology concordant with the emerging theory of cosmic evolution. A unified, rather than a fragmented curriculum is essential. Likewise, the breach within and between the sciences and the humanities must be bridged by more communication and cooperation. Finally, comprehension of the past is crucial for planning the future. Hence the evolutionary world view can and must provide the main unifying approach for the liberal education system, and evolutionary studies should become central in the curriculum. Such a curriculum would bridge the sciences and the humanities, reinforcing each other, and advance more integrative and fruitful teaching and research. The educational system faces a major challenge: integrating man's knowledge of the universe and himself into a solid yet dynamic intellectual evolutionary structure. Such efforts necessitate the cooperation of all fields of knowledge guided by unlimited imagination, wisdom, creativity, and humanism to safeguard man's evolutionary future both in the short and long runs. The present curriculum lacks a general message of understanding ourselves and our place in nature, hence it also does not provide an operational guide to control and solve satisfactorily our short and long range problems.
>
> The fragmented, mosaic curriculum on all educational levels, from primary school to university, hardly satisfies man's desire for answers to the big questions challenging him. These involve the following: Who are we? Where did we come from? How are we related to the real world, organic as well as inorganic? What are we doing here and now? What are people for? What is the universe? How and when did the universe begin? How did galaxies, stars, planets and life originate and evolve? Is the universe causal, random, or both? Can the understanding of the world and ourselves relieve us, at least partly, of our individual tragic conditions of loneliness, solitude, and death awareness? Can such an understanding introduce meaning into human life? Neither are we equipped intellectually, morally, nor operationally, by the present prevailing philosophy and methodology of education to confront, let alone solve, the major problems threatening our future. These involve: population explosion, environmental deterioration, world famine, poverty and disease, nuclear war, social and cultural erosion, group-conflict at all levels (family, gang, class, nation), the loss of traditional human beliefs leaving man without meaningful replacements, and last, but not least, the violence and disharmony between individuals.
>
> The above issues call urgently for a drastic change in idea systems, educational philosophy, and curriculum structure. The core of such a revolution of thought must hinge around the better understanding of ourselves and our place in nature based on the integrative human knowledge and wisdom. Such an understanding is essential for fuller realization of human possibilities, for the resolution of our major threats, and for the harmonious planning of our individual and socia

future. If this view is correct, it must be adopted by our educational philosophy and methodology, since both are the major tools for cultural and social change.

We need a change in the structure and orientation of the usually conservative educational system. While specialization and analytical reductionist studies are indispensible and imperative for increasing knowledge in our age, integration and synthesis must provide ultimate goals in order to serve as the basis for a rational world view increasing understanding, and for the reestablishment of faith and belief in man and his future. We need rapid development of studies integrating human knowledge and understanding, thereby unifying our currently fragmented and overspecialized intellectual world. The prime function of education is not to impart detailed information but to cultivate understanding of the real world, including man and his psychosocial sphere. Such understanding is essential for conservation of nature and the control of our future. Interdisciplinarity is an important methodology that can substantially contribute to these goals.

It could be added that it poses a problem that research in universities and colleges normally follows the same organizational lines as the educational effort. It has been maintained by Mr. Kjell Eide, Head of the Planning Department of the Norwegian Ministry of Science and Culture, that this structure could be considered quite irrational from a research point of view. Numerous attempts have therefore been made to shape an internal matrix organization which makes it possible to organize research across the dividing lines of the educational units. As long as research has been able to reap the benefits of sharp growth in student numbers, the development towards such a structure has gone fairly slowly. However, now the fear that a reduced student population may affect the number of researchers has caused attempts to loosen the connection between the educational and research sectors inside the institutions. It is assumed that through this severing process research could expand independent of the scope of education.

Mr. Eide also observes related to this phenomenon the emergence of an extensive system of independent research institutes outside universities and colleges. As long as this tendency occured on a private basis, and mainly in the field of applied research, it was not regarded as a serious threat to the institutions of higher education. Increasingly, however, the new institutes have attracted large public means, and they have undertaken much basic research. This development has been especially striking in the USA, France, Western Germany, and Japan. The strategy of the universities must be to aim at defending their role in the total research picture and strengthen their contacts with external research.

There is an increased need to secure the critical function so far exerted both by research and education in the universities and colleges. Further externalization of research obviously does not give a sound basis for the exertion of critical functions. It poses no problem to share Mr. Eide's point of view that to secure this function is a major political responsibility: the lessons of the student revolt should not be forgotten.

An interdisciplinary approach helps to encourage a healthy pluralism, intellectual generosity, integrity, and independence,

all of which are essential to a sound democratic process and to the promotion of peace and prosperity. As far as prosperity is concerned, one might also pose the question whether we have not come so far that undue specialization at the individual level has become a threat to productivity, not only intellectually, but also materially.

There is also the possibility that the diffusion process is hampered severely by too much specialization. According to Sam Iker,[1] diffusion is the process by which innovations spread from person to person, organization to organization, and region to region. Mr. Iker observes:

> In the past, the appeal of such research cut across a number of disciplines. The data were relatively easy to gather; methods of analyzing the findings were well staked out. Moreover, the results seemed to offer practical answers to real social problems from traffic congestion to runaway population growth. The traditional focus on the pace of diffusion added a unique "live" dimension to the study of behavioral change. And scientists could readily turn their empirical findings into broad generalizations.
>
> The research is still attracting a broad spectrum of investigators. But a rising chorus of criticism has plunged the field of diffusion inquiry into a state of disarray. Nearly 40 years of accumulated research is coming under attack.

Michael Radnor, Head of Northwestern University's Center for the Interdisciplinary Study of Science and Technology, is quoted as saying:

> Diffusion research in its classical from was very useful and valuable in the limited situations from which it grew. It was pretty good for example for predicting diffusion as a specific innovation such as hybrid corn. And the classical approach is useful if you're dealing with a well-defined innovation that can't be changed dramatically and is being diffused among fairly easily defined types of adopters such as individuals.

Because the diffusion, of new ideas, new processes, new products, etc., concerns everybody so much and will have such impact on both the industrial and the developing world in the future, it seems important to go into some detail here. We are in a field where there is indeed little consensus among the various academic disciplines; each discipline focuses on different aspects of diffusion and operates from a different perspective. Mr. Sam Iker, for instance, reminds his readers that studies in the field are done by sociologists, anthropologists, geographers, economists, political scientists, communications experts, psychologists, management and marketing experts and others. In relation to this particular study one should have in mind that diffusion is also "technology transfer," "research utilization," "planned change," "organizational change," "innovation research," and "dissemination and utilization."

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1. Sam Iker, Dialogue No. 3, 1981, reprinted from Mosaic, published by the American Science Foundation

Thus the field of diffusion is indeed an interdisciplinary area with heavy bearing upon science and technology, the socio-economics, environmental and cultural protection, etc. It is also an area where people and nations that lack sufficient critical knowledge may be placed in a very unfavourable position. Usually early innovators collect windfall returns. They are also generally better off, better educated, and more "progressive". They are the ones who collect the rewards that go to those who first adopt an innovation.

In Michael Radnor's view, it is less useful to give people answers to specific questions than to give them models which show how the diffusion process works and what relationships exist between various sets of conditions. An innovation seen as a "single thing, divorced from any context, makes less and less sense". The effects of innovations seem, for instance, to be significantly different in Third World Nations than in developed countries. This fact represents a challenge to interdisciplinary research in a "new" and terribly significant field in which developing countries themselves should take part and be in a position to voice their own priorities.

The United Nations Conference on Science and Technology for Development (UNCSTD) in Vienna in 1979 gave valuable feedback to industrialized countries about the current priorities of developing countries. The impression was that developing countries would give priority to research and higher education which could contribute to finding solutions to problems that they themselves defined.

In line with the Declaration on Science, Technology, and the Future at this conference, fortunately more attention was focused on the consequences of different choices of technology and on the participation of women in decision-making processes bearing on science and technology. Unfortunately, a striking feature of the UNCSTD-conference was that only very few national reports took a critical attitude to the transfer of technology as such. A typical experience, common to developing aid agencies and universities of technology, may serve as an example of "monodisciplinary" factors that hamper the transfer of technology. Probably there was too much and unnecessary equipment transferred, while there was too little technology available for commercial use. Also theoretical projects were introduced that were hardly relevant, and the personnel were exclusively scientifically oriented and lacked the ability to establish contact with potential customers. It is no wonder that the lack of problem-solving research projects was striking too!

It seems appropriate to close these remarks with some advice given by Mrs. Helena Kekkonen, Secretary General of the Finnish Adult Education Organisations[1]. Her comments represent an instance of an interdisciplinary approach in which both feelings and intellect are involved:

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1. At the ceremony at Unesco in Paris, October, 1981, when she received, together with the World Organisation of the Scout Movement, the first award of the Unesco Price for Peace Education. Her remarks are printed in Convergence, the International Journal of Adult Education, Toronto, Canada, Vol. XIV, No. 4, 1981.

First, with the help of a peace education, people must be given a solid base of knowledge about the world situation and the historical factors that have caused it. Far too often people have only separate fragments of information transmitted by mass communication. They are unable to conceive the existing interrelationships, see things in their wider contexts, to form an overall view of the world for themselves.

Second, the methods of peace education should be problem-centred, guiding the process of learning from points of departure close to an individual's everyday life towards an overall view of society and of the world.

Third, I stress the significance of empathetic learning. Even the most adequate information does not necessarily produce attitude changes and new action. The information must become internalized and thoroughly understood by the heart. It is not enough to be well-informed about injustices. The learner must also acquire an ability to identify with people suffering in the world and to place himself in their position. Only this kind of empathetic learning will lead to personal spontaneous action to remove injustices.

Empathetic learning can become possible, for example, through art because art activates the imagination and promotes empathy. It is extremely important to listen to the voices of developing countries and to include the works of art of distant cultures in peace education. To reach true understanding, we need genuine dialogue between different peoples, and we need to listen to each other.

3. THE CONCEPT OF INTERDISCIPLINARITY

The participants of the Bucharest symposium made an effort to elaborate on the concept of interdisciplinarity which, it was agreed, can often be quite diffuse and confusing. As was pointed out already, a great variety of definitions have been offered. The need for refining as well as narrowing down the multifarious formulations was obvious to all.

The point of departure in most such efforts is the discipline. Professor Edmond Nicolau had in his reference document this illustrating description of the process of development of new disciplines:

> From its very beginning, higher education in Europe was based on disciplines. In its archaic sense, discipline was a branch of instruction. Trivium and quadrivium in medieval schools were the liberal arts: grammar, rhetoric, and logic, respectively arithmetic, geometry, astronomy, and music. This represents a classification of disciplines in the European educational system in medieval times. In order to discuss interdisciplinarity, it is necessary to accept a given system of disciplines which can be classified in a hierarchic manner. At the first level we have three groups of disciplines: natural sciences, human sciences, and technical sciences. Within each group we have a number of disciplines; for instance, in natural sciences, we have astronomy, physics, chemistry, life sciences, earth and space sciences, etc. We have within each category of science yet another level of greater specialization. For instance, in physics we have acoustics, electromagnetism, mechanics, optics, thermodynamics, electronics, etc. A proposal for an International Nomenclature of Fields of Science and Technology gives more than 2000 fields under 24 major field headings. It should be noted that every classification is in a sense arbitrary: fluid mechanics is a part of the physics of fluids and not a branch of mechanics. A classification may be acceptable at a given time, but unacceptable at a later stage of development. Every description of a scientific field at a given moment is a synchronous description. The history of science also offers a diachronic description which can throw light on many problems concerning the evolution of scientific ideas. Interdisciplinarity can thus be viewed as a new field emerging from a synthesis of two or more disciplines. From the diachronic point of view, thermodynamics may be viewed as an interdisciplinary field emerging from the synthesis of two formerly separate areas, thermostatics and mechanical dynamics.
>
> The process of interdisciplinary creation of new sciences in our time is a continuous one. Its essence is the methodological approach: the organization, interrelation, and integration of knowledge from various fields at a higher level of discourse, and, consequently, the establishment of a new theoretical synthetic system. Taking thermodynamics again as an example, we see that it was created by a synthesis of two separate models (balance of heat and Newton's law); with reference to the work of Carnot, we have passed to a new model and to a higher level of discourse: the conservation of energy. A new theoretical synthetic system is established, with wide scientific and technical implications.

In her book Interdisciplinary Programs and Administrative Structures: Problems and Prospects for the 1980's, Caroline D. Eckhardt from the Center for the Study of Higher Education at the Pennsylvania State University maintains that the central criteria for a discipline are measures of whether a field of study has academically "arrived": does it have a recognized professional association, a journal bearing its name, an identifiable body of members? In essence, are enough academics engaged in the field in question to make its presence felt?

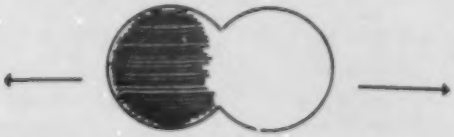
Professor Eckhardt says that it is a fundamental error to assume that the status quo has any special claim to existence on tomorrow's intellectual map. She identifies six processes of change:

1. Diminuition and eventually elimination
2. Change within a field
3. "Fission"
4. "Fusion"
5. "Recombination"
6. "Spatial completion"

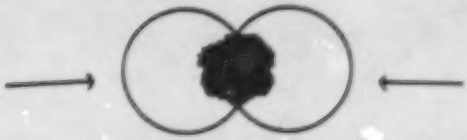
Her illustrations and comments are so useful that they deserve to be copied here in extensio:

> At any one time, several processes of intellectual and institutional change in the structure of knowledge are likely to be active. One process of change involves the diminution and then the elimination of a field of study that, as time passes, is no longer felt to be valid at the university level. (Astrology was once respectably studied, but is now absent from university curricula). A second process is change within the content, methods, or goals of an established field of study. (Given the impact of the theory of evolution, biology is no longer what it was in the mid-nineteenth century.)

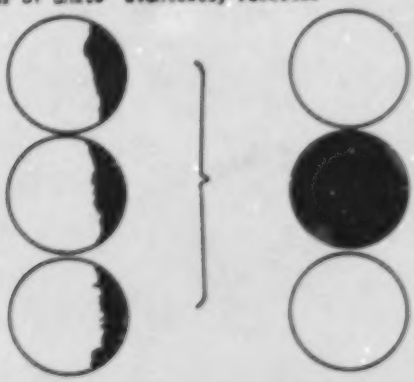
> A third kind of change involves the increasing differentiation of areas within a field of study until two or more distinct fields are recognized to exist. The metaphoric term "fission" has been applied to this process.



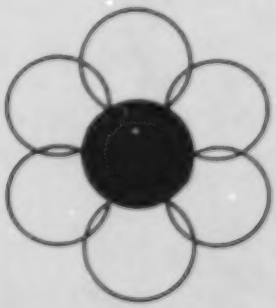
A fourth kind of change involves the unification of areas formerly seen as distinct; this process has been called "fusion."



A fifth pattern of change might be called "recombination." It is simply the operation of fission and fusion together, affecting a group of fields of study so that a new array--perhaps preserving the same total number of units--eventually results.



A sixth pattern of change might be called "spatial completion." While it involves some fission and some fusion, it results primarily from the perception that existing fields, arranged in a certain way, create a significant space at their edges or in their midst. A new territory for exploration, once perceived, will be occupied in order to make our presence in the universe of thought seem again complete. It is man, not nature, that abhors a vacuum.



To some of these processes of change, the university as an institution can respond rapidly and easily, particularly when its resources of money and personnel are ample. The gradual elimination of a field of study, while painful to the people directly involved, may even be welcomed by those who remain. Change within a field also causes minimal stress. It normally disturbs the equilibrium of only those practitioners within the field who are individually unable to cope with the new expectations; the university as an institution is not much affected. At the other end of the range, the process of spatial completion, involving the perception of genuinely new fields of study, can also be accepted with relative equanimity if resources are ample. If resources are not ample, the university can simply decide that it will not add the new field to its domain; other universities will have to populate the territory that has been discovered - at least for a time. It is the intermediate processes of fission, fusion, and recombination that cause the most discomfort, since they imply a structural rearrangement of the university's existing component parts.

It is well recognized that the modern university, at least in Western countries, finds itself in a paradoxical situation. It tends to be far advanced, sometimes even radical, in its knowledge-content and in its social ideas on the one hand. It tends to be highly conservative, sometimes even reactionary, in its management of itself as an institution, on the other hand.[1] To respond to the several processes of epistemological change identified above would require great agility, reasonableness, foresight, and a high degree of freedom of movement. At the present this last, at least, is less and less possible to the universities as they become increasingly tenured-in and as the proportion of fixed costs in their budgets rises. It is not surprising that in many universities very little is done to facilitate the change processes described above.

It is interesting to compare these categories of discipline change with professor Asa Brigg's summing-up of the development of the field in a recent historic perspective (International Encyclopedia of Higher Education, Vol. V, pp. 2208-2212; Working Document ED-81/CONF.802/2, p. 2):

> By 1960 the familiar distinction between general and specialized education, a university tradition since the nineteenth century, was beginning to appear inadequate to meet the needs either of teaching or of research. Meanwhile, as the public stake in higher education increased, the public began to pay more attention to the qualifications of university graduates. The institutional and market demand increased for students who were flexible and adeptable and for students who were prepared to tackle problems requiring a knowledge of more than one discipline.

1. E.g. Gass, "Preface," Interdisciplinarity, p. 9.

Nevertheless, there was still little talk of interdisciplinarity. Only when it became apparent that positivist approaches to specialization in many fields were producing inadequate research results did reaction against such specialization begin to set in. Spectacular advances in the biological sciences as a result of interdisciplinary interactions during the early 1960s did much to further the cause of the interdisciplinary approach. Soon thereafter, there were demands that the social sciences should follow suit. Similar demands for change were made in engineering, both at the undergraduate and at the research level, as the old divisions between mechanical, electrical, and civil engineering became obsolete. In anthropology the very concept of a discipline began to stand in the way of the kind of structural analysis that was beginning to transform the field. Meanwhile, many areas of study were beginning to use mathematical language and to make greater use of computers. In the course of these developments, unsuspected affinities and relationships between subjects were being discovered, and new epistemologies were developing. During the 1960s a new series of external circumstances - a combination of social and intellectual influences - fostered the emergence of new clusters of studies.

The Working Document for the Bucharest symposium referred to above underlines that, parallel to the evolution now described, a clarification of terms appears necessary. However, in a Unesco context an agreement had already been reached prior to the conference (ref. 113 EX/4 Aug. 14 1981 para. 426, note 1). In this document, Unesco proposed to define:

> multidisciplinarity as the simple juxtaposition of different disciplines without any apparent connection between them; pluridisciplinarity as the juxtaposition of disciplines supposed to be more or less related; interdisciplinarity as a form of co-operation between different disciplines with regard to problems whose complexity is such that they can only be apprehended through the convergence and careful combining of different points of view; and transdisciplinarity as the reference to a general axiomatic system or to a theory which enables a group of disciplines to be brought together. A simpler distinction may be made, however, between pluridisciplinarity and interdisciplinarity. Pluridisciplinarity is then understood as the association of various disciplines contributing to the achievement of a common end, but without the need for any appreciable modification in the particular approach and methods of each discipline or specialist. In epistemological terms, the concept of interdisciplinarity may be regarded as a form of co-operation between various disciplines, which contribute to the achievement of a common end, and which, through their association, further the emergence and advancement of new knowledge.

For all practical purposes, it may be wise to stick to the definition of interdisciplinarity referred to here. After all it has a kind of official status and may operate as an approved basis for international dialogue. In this study, however, there is an opportunity to go into more detail.

At the Bucharest symposium, two models were proposed as possible and recommendable. The first relates to levels of "interdisciplinarity" and was in its several versions familiar

to the participants, to the extent that everybody seemed to have his own ideas regarding how far the differentiation related to levels should go. The second alternative may be described as rather more problem-oriented. There was consensus in the conference that the latter model of differentiation merits consideration as an alternative to the more generally accepted model. As regards the latter, the thinking may be summarized as follows:

A reasonable point of departure will include a quantitative as well as a qualitative aspect. The qualitative aspect manifests itself in the degree of influence exerted by the respective disciplines in the cooperative process. If one discipline is dominant, quality is poor. If the influence is balanced, quality is high.

A. Transdisciplinarity is a state of complete balance of influence between all relevant participating disciplines at the highest possible level of coordination. Coordination in this sense entails an optimum of cross-contact or cross-communication. The extent and quality of cooperation are both so advanced that a new discipline may be established analytically and socially. When we estimate the relative success or failure of interdisciplinarity, during the last decade or two, it seems important to bear in mind that such new disciplines have actually arisen!

B. Interdisciplinarity is somewhat weaker than transdisciplinarity in coordination or croos-communication. The balance of influence, however, of the respective disciplines, is upheld. The total impact of the quantitative and qualitative elements is not strong enough to establish a new discipline. One may, however, discern some analytical building blocks which could be useful to such a process.

C. Cross-disciplinarity deviates from interdisciplinarity in both the quantitative and qualitative senses. Regarding the latter, the potential for balanced influence has disappeared; one discipline dominates the others. The degree of communication is also fading to the extent that one can hardly talk of a mutually accepted system of coordination anymore. The dominant discipline is the one that establishes all important premises. In some milieus of education and more seldom of research, interdisciplinarity is accepted as the best compromise that can be achieved under the circumstances.

D. Pluri-disciplinarity is characterized by the fact that communication takes place between various milieus or disciplines, but the contact may be weaker or more sporadic than in cross-disciplinarity. A positive factor is that the communication is symmetric, not assymetric as it is in cross-disciplinarity. The qualitative aspect improves as the influence on a given project of education or research is more evenly exerted.

E. Multi-disciplinarity is the least developed form of inter-disciplinarity. The communication between the various milieus is reduced to a minimum. Yet projects of education or research are often overlapping or complementary to each other. They thus represent a potential for future connection and the milieus an unrealized potential that could later be mobilized towards a common end. It may thus be worthwhile, for a start, to put the subject elements in juxtaposition with each other to illustrate their common aspects.

As was pointed out by the author of this study in a contribution at the symposium, one may draw the factor of relevance or goal-orientation of higher education and research into the definitions of interdisciplinarity. Categories such as the following could then be elaborated:

A. Value-neutrality
B. Value-relevance
C. Value-realization
D. Value-definition

These categories would then be value-orientated and could be included in a matrix with categories like:

A. Exonomy (dominantly client or user influenced)
B. Heteronomy (relative degree of interdisciplinary researcher/educator or research result buyer/student influence)
C. Autonomy (dominantly researcher influenced)

We might find that, for example, a representative number of interdisciplinary projects, when put into the matrix, could give us a clearer sense of our international cooperation in higher education or research according to their goal-orientation and governing forces. We would then, however, be challenged with the formidable task of estimating the results of interdisciplinarity, and even more difficult, of sorting out the preconditions for "good" or "bad" interdisciplinary education or research.[1]

One aspect of such philosophy (for the research effort) is indirectly expressed by the Norwegian Labour Party in one of its recent long-term programs in the form of a demand for social relevance:

> A substantially greater part of the research effort should take place in fields of greater importance to society, especially in fields that pertain to the transformation of society. This applies, for example, to research on social topics, education, environmental problems, the economic system, housing and building activities, the working environment, topics of communication and traffic, etc.

It may, however, be recommendable to restrict oneself to a definition of interdisciplinarity that covers the actual use of the term in the region. According to the summary of the Bucharest discussions:

> 'Interdisciplinarity' implies a certain amount of integration between different areas of knowledge and different approaches and the development of a common language which permits conceptual and methodological exchanges to take place. (Working document, p.3). To develop a common language is very important in order to enable initial communication within research and teaching.

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1. For reference see "Report on Interdisciplinary Research," Oslo 1975, issued by the Central Committee for Norwegian Research (in Norwegian only).

The second and alternative approach, which was elaborated in some detail at the Bucharest symposium, was presented by the elected Chairman, professor Vosskamp (Bielefeld, FRG), and outlined in his paper to the conference as follows:

Over the years, a number of perspectives of the theory and method of interdisciplinarity have evolved as a result of the activities of the Center for Interdisciplinary Research. No distinctions have been made between "interdisciplinarity", "multidisciplinarity", and "transdisciplinarity". Rather, there are four "types of interdisciplinarity" which can be identified as follows:

1. Interdisciplinority of neighboring disciplines
2. Interdisciplinarity of problems
3. Interdisciplinarity of methods
4. Interdisciplinarity of concepts.

(G.C. Huekamp, D. Kestermann, S. Sjölander, A. Triebel, Criteria of Interdisciplinarity. Considerations by some of ZiF's academic staff; in: ZiF 1968-1978, Ten Years in the Service of Interdisciplinary Research, Annual Report, 1978, ZiF-Bielefeld, pp. 23-24)

1. Interdisciplinarity of neighboring disciplines:

Under this heading one could include cases in which two areas of science are becoming so closely involved with each other that there is an overlap to which both disciplines can contribute both methods and concepts. One example of this sort of contact was the research project on "Early Development in Animals and Man" in which the field of behavior development was a concern of both psychologists and ethnologists. Their points of departure were quite different, however. The psychologist had to take into account the individual development as well as any character traits and/or pathological reactions which had evolved in the course of development; whereas the ethnologists had to study fundamental, species-specific phenomena of normal development. In such a case the mutual benefit from interdisciplinary work was immediately obvious, but it was emphasized that such collaboration is useful only when there is a genuine overlap. The existence of such an overlap would be evident in a significant number of publications dealing with such problems in the major journals of biology and psychology.

It was also suggested that quite often new research areas are opened up in such borderline (Grenzfeld) areas because neither one nor the other discipline can supply sufficient concepts, methods, etc. In response to such a situation in behavior ontogeny, the Max-Planck-Institute of Psychiatry in Munich has set up a department of developmental psychobiology.

In addition to psychology, which has been mentioned, there is also a borderland between chemistry and biology, as well as biophysics which provides a bridge between physics on the one hand and biology on the other. An institution such as ZiF (Centre for Interdisciplinary Research - Bielefeld, F.R.G.) could take the initiative in identifying such research areas. A warning was given, however, that those projects which provide scientists only with a general survey of what goes on in the neighboring disciplines cannot be regarded as interdisciplinary.

2. Interdisciplinarity of problems:

In contrast with the previous type of interdisciplinarity, this one could apply to certain problem groups which cannot be included in a specific discipline and contain so many aspects that they could not be taken care of by just one discipline. The collaboration of several disciplines would therefore obviously be desirable. Examples of this interdisciplinary category are the majority of ZiF workshops, e.g. on urban redevelopment. It was emphasized that such problems cannot be dealt with by simply putting together points of view. Rather, they demand the researchers' joint defining of the themes to be covered. It should also be clearly stated to what extent the findings of disciplines other than those represented in the research group could be used and to what extent a feedback can be expected to the various disciplines. It is also relevant to ask why specific problems should be studied from an interdisciplinary angle at any particular time.

3. Interdisciplinarity of methods:

This type of interdisciplinarity is most likely to occur when methods peculiar to one discipline can be used for research in other disciplines as well. One difficulty was mentioned, however: Can one speak of interdisciplinarity when one discipline makes use of an auxiliary science (statistics, for instance) without the latter gaining anything from it? Or should it be anticipated that both disciplines will mutually benefit from each other, for example in game theory and its use in evolutionary biology. Game theory has thus far proved beneficial to evolutionary biologists while providing game theorists with some new insights when confronted, as they were, with new problems.

4. Interdisciplinarity of concepts:

This type of interdisciplinarity refers to a situation in which models and concepts have been developed in one discipline and are then used to supplement research in another discipline or even supplant existing models and concepts. Our experience has been that the theory of evolution is obviously of interest to psychology since biological and historical perspectives greatly enhance psychological research. Psychological concepts, particularly when referring to the individuality of behavior, have in turn added some useful ideas to evolution theory.

The question of whether one can speak of interdisciplinarity when the benefit of methods used is unilateral could also be asked in relation to concepts, although in practice few concepts can be transferred unchanged. In a modified form, a given concept could provide a stimulus to the discipline from which it originated. The application of concepts from other fields or disciplines must not, however, be an excuse for hiding undeveloped or unsubstantiated ideas. The choice of projects should be made contingent on a detailed presentation which delineates the concepts concerned and why they are interesting and transferable.

It should be noted that even if the concept of interdisciplinarity appeared in several versions the participants of the symposium were agreed that problem-oriented questions are recommended as a starting point of interdisciplinary research programmes and as a condition for a synthesis in study courses.

We should mention that the atomization of science seen nowadays is to a considerable extent counterbalanced by an increasing integration of various scientific disciplines during the process of research. Following Stojanovic,[1] interdisciplinary cooperation (depending of the nature and number of disciplines involved) could therefore be classified as follows:

A. Iso-disciplinary cooperation, which is effected within the framework of one fundamental discipline

B. Ino-interdisciplinarity, which occurs between various related disciplines within one particular group of subjects (e.g., medicine, engineering, law)

C. Hetero-interdisciplinarity, implying cooperation between unrelated scientific disciplines, either within one particular group of subjects or within the framework of various groups (cardiology and mathematics, law and medicine, etc.).

Last, more or less parallel to the categorization of the 6 types dealt with above, we have the hierarchial levels presented by Heinz Heckhausen.[2] With respect to the degree of synthesis and fusion of fields of knowledge achieved, his denotations are the following:

1. heterogeneous interdisciplinarity (of encyclopedic character),
2. pseudo-interdisciplinarity,
3. auxilliary interdisciplinarity,
4. composite interdisciplinarity,
5. complementary interdisciplinarity (seeks to establish a correspondence between various disciplines at the level of theoretical integration and emerging at the frontier of two sciences) and
6. unifying interdisciplinarity (with a high degree of coherence between two closely related disciplines).

For practical purposes, one is again apt to fall back on "interdisciplinarity" as an intermediate concept to be found

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1. V. Stojanovic, "Scientific interdisciplinary cooperation in current development of science and research work," In: Communication, Nottingham, 1978, No. 6, p. 9.

2. Heinz Heckhausen, "Discipline et interdisciplinarité," In: Le Bulletin de l'Association Internationale des Universités, Paris, 1972, No. 3, p. 167.

somewhere in the middle of this hierarchy. Erich Jantsch[1] speaks about interdisciplinarity in terms of a synthesis of two or more disciplines by which a new level of discourse, a metalevel, is established. He thus supports the view that it may be sufficient to state that interdisciplinarity is an intermediate concept between multi- and transdisciplinarity, and he restricts himself to offering contrasting definitions for these three categories. In this connection it is also interesting to note the minimum conditions for an interdisciplinary approach as they are outlined by the Romanian Commission for Interdisciplinary Studies in Bucharest. The requirements are:

A. the postulation of an integrative principle on a metatheoretical level,
B. a semantically closed language,
C. formalization by recourse to axioms without effacing the qualitative aspects,
D. the establishment of a theoretical level corresponding to the level on which the axioms have been set up, and
E. the definition of the relations holding between the integrated disciplines and the status of the respective disciplines.[2]

Perhaps such minimal requirements can be a help in situations where multiple definitions of interdisciplinarity confuse and pose problems. As Tom Conelly and Dan Clark have recently pointed out,[3] this is especially the case for administrators attempting an interdisciplinary approach. According to these authors, the greatest challenge for the administrator may not be to facilitate development of innovative instructional forms, but to deal with complex organizational change. Such specific administrative decision-making occurs on two levels: those decisions which start the process of change (organizational goal setting, problem diagnosis, and implementation of postures necessary for interdisciplinary development) and those that relate to the issues of implementation and maintenance of the interdisciplinary activity itself.

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1. Erich Jantsch, "L'interdisciplinarité: les rêves et réalité", In: Perspectives, Paris, 1980, vol. 10, no. 3, p. 333.

2. Marilena Lunca, "Definition of the Concept of Interdisciplinarity." Interdisciplinarity in Contemporary Science, (Bucharest, 1980), p. 389.

3. Tom Conelly and Dan Clark, "Developing interdisciplinary education in allied health programmes. Issues and decisions." EMIC ED 192 525, 1980, vol. 15, no. 7.

4. THE CASES

This chapter which constitutes the major part of this study will focus on practical cases of interdisciplinary study and research. As studies and research are normally closely linked at the tertiary level of education, these two fields of interdisciplinarity need not be treated separately. Yet, the closer they are intertwined, the more fruitful are usually the programs in question.

Two points should be borne in mind: First, it is not the purpose of this study to concentrate all attention on the successful cases. It may be equally important to try to throw light upon why good intentions fail to be realized or experimental efforts are modified to such an extent that they can hardly be labelled interdisciplinary even in a liberal sense. Second, the narrow time limit of this study has made it necessary to concentrate attention on a few European, and one or two American examples. This narrow scope may be legitimate because the Bucharest symposium dealt chiefly with the European scene.

A. The Norwegian Regional Colleges.

As members of the national system of higher education, the Norwegian regional or district colleges have a special responsibility for interdisciplinary, vocational studies at the tertiary level. The major part of their activities are directed towards ordinary full-time students who normally perform studies of one to four years' duration. Since the modular course structure is often applied and lectures and other activities to a great extent also take place in the afternoons and evenings, the number of part-timers may sometimes exceed the number of full-time students. The regional colleges have a research mandate, and their professors (associate and assistant) have academic and professional qualifications which match those of their university counterparts. The chief emphasis is on applied research and development work, often strongly directed towards solving problems that emanate from the region, district, or local community.

As it is not possible in a short study to cover much ground, even in a new and experimental field, The Oppland Regional College, Lillehammer, may serve as a model because of its project-orientated philosophy and well documented practices. The following few examples of goal formulations, pedagogic organization, and applied research, may serve to illustrate representative on-going activities:

I. A project-oriented part-time study for high school teachers

1. The philosophy for the study contains these ingredients:

   - An orientation towards the totality rather than towards the parts.
   - A pedagogic situation which makes it possible to understand and elaborate upon the problems of the high school students on the basis of the concept that the student is a whole human being

- A problem-orientation which serves to prevent a subject-specialized perspective.

2. Goal orientation rather than organisational orientation.

   The students apply functional working methods in which the work models are related to all-embracing goals. Institutionalized patterns of thought and working routines are discouraged.

3. Orientation towards relations rather than towards the individual.

   An individual orientation entails that problems are always centered on the person. The focus is on the interplay of all participating partners.

4. Causal orientation rather than symptom orientation.

   The educational situations are arranged in such a way that the students get ample opportunity to analyse and solve problems in school and society which may be the same problems that they themselves confront as high school teachers.

5. Reflective action orientation rather than technical or methodological action-orientation.

   Technical solutions to problems are considered critically in light of their consequences for the school, society and for society at large.

6. Problem-orientation rather than discipline or subject orientation.

   The various elements of the educational situation are integrated in such a way that the students will discover how the elements of the educational process are integrated with essential problems.

7. Cooperative orientation rather than individual orientation.

   A team-organized study form is motivated by the problems of cooperation within the school society itself, as well as by the general principles of adult-oriented pedagogics.

8. Dialogue orientation rather than directive orientation.

   It is strongly felt that dialogue is indispensable: it comprises partnership, personal responsibility, confidence, openness, mutual respect, and care. Dialogue that involves criticism and self-criticism provides a necessary means to improve the work process and product. To the extent that such a dialogue is real, the work teams increase their potential for self-government and decrease their need for instruction and control.

9. Resource development.

   High school teachers are the most important resource of high schools. The working methods and the plan for the study trigger a development of resources that

may serve to inspire the high school teachers in their work with their own high school students.

For this study three problem-areas have so far been selected. They are:

- Secondary education in an ideological and societal perspective.
- Differentiation between students and the consequences for the school society, the educational process, and treatment.
- Models and problems of cooperation.

One significant priority of the pedagogic milieu at the Lillehammer Regional College is to endeavour to throw some light upon the interplay between the development (and change) of society and educational reforms. This emphasis also includes the study of preconditions for reform.

II. The studies of social and political science and public planning.

Just as in the pedagogical field at Lillehammer, study under this heading is also available in more than one version. The goals of one version are:

- To acquire insight into connections between current problems of society and practical politics with a view to sort out how politics shape our everyday life and cultural and material living conditions.
- To acquire qualifications for and experience in analyzing the political decision-making processes and the political power conditions in society, focusing particularly on the public decision-making processes.
- To acquire ability for teamwork and cooperation and to share collective responsibility.
- To acquire an action-oriented professional engagement.

The goals of a second version (a two year post-degree diploma study) are, by comparison:

- To study how sectorial planning in one sector affects other external sectors.
- To study how external conditions and events affect ones own sector.
- To study the connections between health planning, social planning, industrial planning, and physical planning.

In an interdisciplinary context, it is of particular interest to note the main motive for using themes and problem-areas in the educational process:

- Subjects are usually developed in accordance with the sectorial divisions of the public. A prime target of the study is to develop a sector which penetrates understanding of the problems of municipalities and counties.

- If the study is built around subject areas or disciplines, even the professors will easily be defined according to their own disciplines. It may then become more important for the subject lecturer to further his own subject than to contribute to the development of an interdisciplinary understanding.

Another attractive aspect of this study is that it has as its expressed aim to direct attention towards interconnections in society. The consequences of different measures taken or not taken are looked upon as equally important. Any particular study team, however, is limited to subjects, methods, and perspectives which are clearly relevant for the planning process analysed and which form the basis of an analysis of local society/macro society relations, with the former as the point of departure.

The theme for the diploma thesis may vary from specific planning and development projects to research-oriented undertakings. The cooperation with public planning bodies may be quite close.

III. A study of contemporary history

Without going into too much detail, the study of contemporary history at Lillehammer also deserves to be mentioned as an instance of an interdisciplinary approach. The stand of the college is that the historic reality should always be regarded in one perspective. Several sub-perspectives serve to create such an overall conception, for instance, the following, which all contain strong interdisciplinary aspects:

1. The problem-solving aspect.

   During a given epoch of history some problems will be resolved. The solutions found give rise to new problems which the following epochs in turn will have to solve. The challenge is to define and seek solutions to the alternative problems caused by the alternative solutions. Many problems have occurred as a result of solutions found during a period of considerable economic growth, solutions that caused excessive pressure on scarce resources, pollution, urban concentration, and a wide variety of social problems.

2. The harmony/conflict aspect.

   A strong interdisciplinary effort is necessary either to synthesize the patterns of harmony or the patterns of conflict, or, even more challenging, to reconcile both in one perspective. In time, change and causes of change in such patterns may reveal important prognostic factors for the further development of society.

3. The power aspect.

   One of the largest and most far-reaching research projects of an interdisciplinary nature ever undertaken in the Nordic countries was completed in Norway in 1982. It is an analysis of the power structures

of the Norwegian society. Researchers of two or three regional colleges have taken part in this big project on an equal basis with their counterparts at several universities and research institutes. To the Lillehammer regional college such queries as "Who were the most influential and in what contexts?" "From where was the power of persons and bodies derived?" "Which interests profitted from influence exerted?" were highly relevant and are still continually raised. Today, knowledge of the sources of power and its distribution is a vital ingredient in the debate concerning the influence of experts and bureaucrats, parliamentarians, trade unions, and professional organizations. Group solidarity as an influential force is a substantial factor now attracting attention to an unprecedented extent.

4. The social inequality aspect.

   Even if "meritocracy" to some extent makes social status independent of privilege by birth, such privilege still exists in modern European society. Such privilege gives rise to social inequality which needs to be analysed in an interdisciplinary context and, if possible, counteracted.

5. The change/continuity aspect.

   To focus on factors of stability and of change in the historic process is of course a common and rather traditional approach. It should also be an inter-disciplinary one.

It is interesting to note that the college at Lillehammer is fully aware that even a phenomenon of the past should be analysed in its full context, i.e., in relation to the economic, political, and cultural situation of its contemporary period. The thematic dimension requires that themes illustrate these aspects as well as social development at large. Connecting lines between the themes should be drawn regularly across epoch boarders.

IV. Research in the regional colleges.

An important activity of the regional colleges is their provision of resource centres for their regions. A decentralised geographical platform often makes it easier to engage in research of problems and that concern counties and local communities. The milieus in and around the regional colleges have brought these problems into focus. Many of these problems cannot be solved without an interdisciplinary approach. More often than not the initiative needed to face new challenges also triggers fresh resources and helps to increase the total financial potential of the vital research sector. Earlier there was a tendency to let part of this potential rest unused, now it is felt right up to the national political level that one cannot afford such waste anymore. The scientific milieu has come to the districts, and it should be used!

In Norway it is also of considerable concern to the universities that their share of the governmental R&D grants has gone down from 48% to 40% during the ten-year period 1971

to 1981. The new willingness and ability to focus on burning problems in the regional environment may help to reverse this trend if the universities can buy the idea that the regional colleges are indeed a legitimate part and partner of the total research milieu. Fortunately the universities have slowly but increasingly come to do that. The possibilities for cooperation between the two sectors in the binary-tertiary system may now be facing a breakthrough. Even if a recent White Paper is considered too sober from a regional point of view as it concerns the potential for further decentralization of research, the importance of finding joint projects in which researchers from both sectors participate is underlined. A special committee on the decentralization of research, chaired by professor Olav Mesjedal of the Telemark Regional College has contributed much toward putting regional problem-solving research into focus, and the response of the National Research Committee and the Government to the proposals of this important paper are now being anticipated.

It would go beyond the scope of the present study to go into detail about a number of projects that are at the same time socially relevant, problem solving, and interdisciplinary in their approach. Let it suffice to mention a few which are chiefly from the socio-economic field:

- Mapping and analysis of integration and concentration tendencies and scale effects in an industry of great impact to the district.
- Analysis of aspects of the international economic system Norway is part of, to make clear the effects that system has on industrial life and on national economy.
- Long term aspects of the industrial development of a region.
- Analyses of consequences of large practical measures (plants, investments, etc.) for small societies.
- Problems of political selectivity in remote districts.
- Structural analysis of industry in a county in order to investigate the exposure to external competition.
- Comparison of the policies and structural patterns of enterprises with the politics and structure at the national level of the economy.
- Development of planning models aimed at forwarding the planning process of municipalities and counties.

These examples are of course too compressed to convey an impression other than a purely thematic one. One example may therefore be described a little further. It has to do with the process of structural change in England and Norway based on the goals of local employment policies:

> Case studies will be performed in the innermost parts of Eastern Norway. They will be done at enterprise level. The idea is to examine enterprises that have already been closed down, will be closed down, are reorganized, or will be reorganized. The enter-

prises will be selected in close cooperation with the regional development departments and industrial boards of the counties in question. The intentions are to examine the ways in which the "local policy constellation" (local authorities, local members of Parliament, local trade unions, local pressure groups, the firms concerned, local branches of central government agencies) react to, attempt to influence, or formulate policy changes.

This project is a joint international venture involving Oppland Regional College at Lillehammer (see educational studies above) and Bristol University, England. (Project leaders: Noralv Veggeland and Tom Davies, Project title: "The Implementation of Economic and Social Goals in Manpower Policy: A Comparative Study in Norway and The United Kingdom." Start of project, 1982).

From the Norwegian point of view the significance of the study is threefold:

- It is important for public authorities and regional development bodies to get a better understanding of what structural change and development entails: what are its driving forces, who influences the profile and implementation, what target conflicts are there, and what potential for action do local organizations have when it comes to shaping a locally adapted employment policy?

- The innermost districts of Eastern Norway go through a difficult period of transition. It is important for the regional and industrial authorities to get a clear picture of successful and unsuccessful measures in their employment policies.

- A comparative study will give new insight as well as new perspectives on our own situation.

Is this not just what we expect of an interdisciplinary approach?

B. The Danish University Centres.

Two of these centres are of particular interest to a study of interdisciplinarity. The Roskilde University Centre (RUC) is highly experimental and widely discussed for its untraditional approach. It may also serve as a useful frame of reference as a radical counterpoint to the strict disciplinary approach of traditional higher education and research institutions. The Aalborg University Centre (AUC) represents a less experimental approach than RUC, but it is much more accepted by society at large and by the national higher education authorities.

1. AUC (Aalborg universitetscenter).

The AUC and RUC were both established during the first half of the seventies as alternative higher education institutions. In both, the basic philosophy was expressed in various manners. The motivation for the social science area of AUC was expressed in this way:

> The total quantity of knowledge is rising at an explosive pace at the same time as the accelerating pace of change causes a steadily more rapid aging of this knowledge. In the context of education this leads to a movement of relevant knowledge away from the factual in the direction of the theoretical and methodological; Simultaneously, social systems become more differentiated and the possibilities for the steering of social development become more dependent on the possibilities of communication.

Inside all the main scientific areas of natural science, the humanities, and social science, an unprecedented flowering of smaller and larger specialized disciplines has been established. They are typical in that they concentrate their efforts inside narrow perimeters and evade placing the problems in a total perspective. Dissatisfaction with social science research has become apparent among scientists as well as individual citizens. The criticism of the social sciences is focused on the fact that the extensive, complex, and dynamic nature of the problems of society relates badly to a scientific tradition which in its thinking operates with narrowly defined categories to solve the problems belonging to small isolated systems. The dissolution of the incompatibility between the problems of society and the scientific restriction of them should therefore be regarded as a substantial goal in the establishment of a university centre.

The criticism referred to above includes criticism of subjects lectured on, divorced from contexts in which they can be applied by society. It also includes criticism of the fragmentization and lack of interdisciplinary, action-oriented activities in which students of different subject areas can work together.

The remedy proposed by AUC and RUC was to begin one- (AUC) or two-year (RUC) basic interdisciplinary study programs. These programs should be broadly composed of different subjects. Such a basic approach is geared to underline their common scientific qualities. Among the specific goals, the following deserve mentioning:

- Greater flexibility of study programs
- Final exams at different levels
- Facilitation of contact between the researchers of the various disciplines
- Development of new subjects in the borderline of existing subjects
- Intensive use of costly technical facilities
- Larger departments with a cross-disciplinary composed research staff
- Common facilities like canteens, meeting rooms, libraries, EDP.

At AUC, the emphasis was put on horizontal integration across subject boarders with not much vertical integration, (i.e., integration of study programs according to how academically advanced they may be or to their duration). This is one aspect of the model chosen which was criticized in a well-documented minority report which stressed that one could not reap all the

benefits of a problem orientated approach due to limited possibilities for function-oriented applications.

One particularly interesting feature of the AUC model is its student project. This project is problem-oriented, and it is a chief element of the basic study program. The theme chosen by a group of students should be dealt with from various angles, it should give rise to a discussion on the basis of several scientific theories, and several methods should be applied in a concrete problem-solving process. The students should themselves learn to formulate a problem, to collect relevant input material systematically, and to apply it operationally.

The project is chosen by the students under the guidance of their professors. The professors contribute by indicating a cluster of possible projects that are in line with the research effort made at the centre during current years. They act as consultants for the student project group while the work is being done.

The projects vary in character, from action research to application of scientific methods or analyses of abstract and theoretical problems. The normal model entails:

- a formulation of the problem
- empiri
- a relevant theoretical basis
- adaptation of theory on empiri
- solution alternatives.

A common denominator can be:

- problem definition and concretization
- planning of work procedure
- execution: data and resource collection, readjustment and control of the work in relation to the problem formulated
- finalizing of the project work
- evaluation.

Project work, of course, does not represent a new approach. The use of it in pedagogical contexts may however present new features. And, disagreement may easily arise at various stages of the process. The most serious problem, however, seems to be that students find it tiring to pose new problems all the time. It is a great challenge to an experimental milieu like AUC's to endeavour to combine projects, problem-orientation, and interdisciplinarity into fresh educational ventures. Nevertheless, even if it is so, the model itself does not seem to be seriously disputed. The basic studies will continue to be a forum where interconnections, interplay, and broad understanding will flourish at the expense of specialization.

At AUC, the research organization, like the studies, are built up around nine large institutes based on interdisciplinarity. A very significant impetus of the educational as well as the research activities is the expressed desire to cooperate with the surrounding community. A system of permanent

contact committees is one of the university centre's responses to the demand made by the North Jutland trade unions in 1973, "that they wanted a cooperating university and not a heap of remote scholarly activity in an ivory tower." Other responses are joint projects and regional cooperation based on theme conferences. The contact committees are:

- between organizations, authorities, institutions in North Jutland and AUC
- between cultural institutions and associations in North Jutland and AUC
- between public authorities and institutions in North Jutland and AUC
- between employers organizations in North Jutland and AUC
- between Trade Unions in North Jutland and AUC
- between educational institutions in North Jutland and AUC.

Their mission is:

- To secure a mutual orientation with regard to regional demands relating to research and education, and also to secure the University's possibilities within the various professional fields.
- To discuss suggestions and ideas aiming at creating additional educational alternatives.
- To discuss specific R&D projects.
- To discuss suggestions for advanced and in-service training within the region.

As a superior target for research at AUC, the Konsistorium (Senate) in 1975 agreed upon the following general criteria for research:

- Projects should, where possible, be of social importance and should be directed towards North Jutland.
- The planning and carrying out of projects should take place in cooperation with other research activities in Denmark and abroad.
- Interdisciplinary research and larger projects are preferred, but should not exclude other research. Research concerning external relations is desirable.
- Operational research as well as fundamental research will take place at the university.

As a result of the open attitude to regional demands, several important projects have been launched. One outstanding project is the North Sea Centre, a training centre for the development of fishing research and business in Hirtshals, now under construction.

A number of activities belonging to the Danish Ministry of Fisheries (a fishery research ship, fishery biological laboratories, a museum and a documentation centre) will be connected to the Centre.

At the same time, the Aalborg University presents new degree courses, namely fishing technology and fishing economics. Apart from its own laboratories the University has also established or is involved in laboratories within the North Sea Centre, some of them in the form of arctic, tropical, and temperate climate plants.

Throughout the planning period, there has been close co-operation between institutes and staff from the university and the other institutions involved in the project. This cooperation embraces a broad spectrum of organizational and professional matters.

In the autumn of 1980, the North Sea Centre received a promise from the E.E.C. of a grant from the regional fund of 40 per cent of the total expenses; and the final implementation of the project, estimated at about a total of D.kr. 130 mill., has now gathered speed.

According to rector Sven Caspersen at AUC, the consequences of this regional development project will be:

- The region will be supplied with direct investment resources of a size amounting to D.kr. 130 mill.
- Four to five hundred additional working places.
- Fishing, a very important regional occupation, will receive strong support in relation to the educational and scientific development of industry.

In cooperation with the county of North Jutland, AUC has also participated in a number of other research and educational activities, such as investigations of:

- the opportunities for the tourist trade in North Jutland
- labour market conditions
- social institutions
- regional planning in North Jutland
- occupational and industrial structure in North Jutland.

However:

The situation of cooperation in North Jutland has not been without conflicts, on the contrary, seas have been running high. At times the conflicts have been based on the academic content of various projects, at times on frustrated expectations, but often also on ideological disagreements between parts of the university population and the partners from outside.

The initial conditions for cooperation were clouded by general suspicion in the population towards the foreign body.

Among many of the newly arrived and integrated staff, there was at the same time a traditional and negative attitude toward getting too involved in North Jutland - a fear of provincialism.[1]

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1. Sven Caspersen, "The Social and Cultural Impact of the University in its Region," AUC, Feb., 1981.

If a university refuses to take initiatives which can strengthen cooperation with the surrounding community, it is possible to share the opinion of rector Caspersen that there may be a serious risk of isolating the university and of losing a substantial part of its purpose. This situation could be dangerous in light of overall economic prospects and the possible resulting aversion to public spending.

2. RUC (Roskilde Universitetscenter)

The philosophy behind the RUC model was the increasing awareness that the traditional system of higher education is not flexible enough and lacks the means to analyse nature and the realities of society. Theoretical knowledge was too seldom related to the area in which it could be applied. The narrowly defined disciplines had become autonomous and isolated universes. The students easily became too specialized to be able to relate their theories, subject-matter, and problems to those of other disciplines. Such a system may have bad consequences for decision-making processes in society when judgements of one sector show no regard for what is taking place in other areas.

Again we see the three main principles applied:

A. Interdisciplinarity

The basic studies (which, it will be remembered, are of two years' duration at RUC and one year at AUC) are established as a reaction against early and strong specialization. This program requires the ability to benefit from the subject-matter and methods of a number of different scientific disciplines. An overall study target is to develop attitudes, resources, and working methods suited to solve the problems that arise in life situations.

B. Problem orientation

The world is full of problems that need to be solved. Education endeavors to grasp these problems and to handle them. Ideas for alternative solutions need to be presented and discussed. The instruction material should be input for the problem-solving process, not an end in itself. The contents of education should not be atomized.

C. Teamwork

To be able to work together in groups is a major requirement put forward by society vis-à-vis persons who have gone through higher education. At RUC it is regarded as a prime duty of the university to arrange the work process in such a way that this end can be achieved. The students should themselves define and choose their study goals, build their curricula, and work together towards a realization of their projects. Undesired individualism and competition are discouraged through the collective work process itself.

To meet these ends, the studies are organized in three main areas:

A. The Humanistic Area

The main theme here is Society and Culture, as expressed through language and texts. The study target is to develop the

students' understanding of their own culture and its historic and social preconditions. Foreign language and history are necessary means to include cultures other than the indigenous one. As many students plan to teach, this university centre gives high priority to ability to communicate insight and experience gathered through the study process.

B. The Area of Natural Science

The theme is Nature as it is described in physics, chemistry, biochemistry, biology, the geo sciences, and their auxiliary sciences: mathematics. electronics and EDP. During the basic studies stress is placed on the shared features of the natural sciences and on the role they play in societies and cultures. The students should be able to analyse problems of natural science critically and methodically on an interdisciplinary basis and to place them in a social context.

C. The Area of Social Science

The main theme here is social life with its acting and counteracting forces, complicated linkages, and abundant unsolved problems. The idea is not to learn a little of this or that but to attack problems of everyday life, and, if one is keen and competent enough, to find relevant solutions to burning problems.

In all these areas, critical analysis is essential. It should not take place in separate institutes or institutions but inside the integrated university centre as such. The three basic studies provide common foundation on which several vocational programs are built which also possess rudiments of interdisciplinarity.

Through the basic studies the students should acquire:

- philosophical, historic-sociological, pedagogical-psychological theories and methods and an ability for communication. (Humaniora), or theories and methods of natural science, and social science;
- qualifications to analyse the social functions the basic studies prepare for;
- training in problem formulation from an interdisciplinary point of view;
- training in linking theory and practical application and in critical estimation of scientific theories and methods;
- training in communication of scientific results also to non-professionals.

Two other characteristics are of particular interest at RUC:

1. The House System

The population of each "house" is normally about seventy people. It consists of nine groups of students averaging seven in each group: five or six teachers and a secretary. This unit is as a general model kept together as a learning unit, and to some extent also as an economic unit, throughout the two-year basic

study. Each student has his regular work place in one of the group rooms close to the teachers' offices. Both these room categories are grouped around a theory room and a common room (the house canteen). All rooms of one "house" have easy access to each other; however, the access to other "houses" is not so good.

The underlying principle for the house system is the so-called DOK-model. DOK stands for "didactical optimalization of the K (or C) properties: creativity, knowledge, communication, combination, and criticism". Two Norwegians, Kjell Askeland (now consultant to the Swedish Research Bureau at the University Chancellor's office, UHÄ, and Per Mandal are the "inventors" of the house model. Their basic idea is that students should be allowed to engage in self-chosen problem areas in a social forum: the group community.

This organizational structure naturally affects the role of the professors. They are "resource persons" who can be drawn upon on demand. The basic group or house collective can avail itself of any teacher for any problem-solving activity.

2. The Evaluation System

Only project reports brought to presentation seminars are subject to external evaluation. Reports are prepared by a group or individual student towards the end of the two-year basic study. The professors and students of the house can take part in the evaluation, if they so desire, together with one or two external evaluators. The "verdict" is either "Pass" or "Fail". This final evaluation is estimated to be a sufficient supplement to day-to-day student guidance and to a running control of active student participation. It should be taken into account that each student and project group always has a teacher who is functioning as an elected consultant through any given sequence of the study program.

Many features of this interesting alternative university have often been presented as controversial by mass media. Unfortunately, student occupation of the university premises a few years ago has no doubt contributed greatly to RUC's image of indiscriminate radicalism. However, even critical conservative minds seem inclined to grant RUC a certain amount of credit for its basic interdisciplinary studies. An unbiased Norwegian observer, Mr. Inge Bø of the Rogaland Regional College, Stavanger, has made these observations which seem quite relevant even to-day:

> To practise team work methodology... makes surprisingly great demands on cooperation and joint action, solidarity and collectivism. At the ideal level it is easy to push such a thought; in practice, it can be very difficult to pursue.
>
> It is not unreasonable to assume that the problems are related to the fact that students and teachers "drew on their past". One has been educated in an authoritarian school system where one has acquired ones qualifications individually, usually even in competition with other people. The teachers have little experience and training in interdisciplinary approaches as well as in project orientation and group work, and there appear to be remarkably few students who are used to genuine teamwork through school. One

has learned how to overcome opposition by being aggressive, dominating, egocentric, and/or dependent, subordinate, etc.; and one is accustomed to learn by oneself. The new study model therefore demands a radical mental change and much trying and failing before one really feels up to it. It may well be that there are students and teachers who, faced with the practical work to be done, are not suited for the collective approach. At RUC there is no alternative.[1]

The Study structure is time-consuming:

I got the impression, says Inge Bø, that occasionally one could sit for hours in house meetings or in the group and discuss controversies which did not necessarily have anything to do with the projects, discuss working procedures, and analyse ways to tackle a problem. Much time is often needed to build up a house or group project. When I was at the Centre last October, there were still groups who had yet not managed to formulate the Autumn project problem on paper. (Here it should be added that the better part of September had been devoted to "pre-packed mini-projects"). In practice numerous reformulations of project targets are required, and for this reason the final result may differ vastly from the original target area.

Like Mr. Bø, one may be inclined to conclude that the Centre may well have started up at a level that has turned out to be too advanced. Mr. Bø missed a more structured approach, especially in the opening phases, and had in addition the following critical comments:

The individual projects of a group or a house may appear to be quite isolated in relation to each other. Did one, to a sufficient extent, underline the continuity or the integration of the projects in the mind of the student?

Is not a certain centration of subjects required in the opening phase? After all every subject has a "relative autonomy," i.e., an individual character, an internal logic, certain concepts, a methodology, theoretical models, problem areas, sub-disciplines, and subject-matter. In a certain sense has not every discipline also some sort of internal "integration," considering the fact that themes, problem areas, etc., are related to each other and to sectors of reality?

To a question like this, the people at RUC would probably respond: The idea is and has always been to avoid being caught in a net of Aristotlean subject differentiation. Is it not much better to arrange an ad hoc seminar whenever specific knowledge or methodology is needed at a particular stage of the problem-solving process? "Our basic principle is de Dewey's "Learning by doing." What is wrong with that?

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1. Inge Bø, Et nytt universitet blir til (A New University is Born), Norsk Pedagogisk Tidsskrift, 5/1974.

Dr. Thomas W. Webb, the first rector, and other spokesmen for the Centre told the Nordic ministry of education representatives that RUC, in their view, stood for ideas and approaches that represented an expansion of higher education, a step toward the universal university. Even the buildings themselves embodied an understanding of the didactic methods applied. At early stages, the spokesmen got a positive response to their interdisciplinary philosophy. Later, after the student occupation of the university and sympathetic actions at other Danish universities, both the Ministry and the politicians finally stopped crying "steady as she goes" and started asking RUC to come about, at least as far as manifestations against government imposed restricted admission policies were concerned. Former Minister of Education Ritt Bjerregård's proposal to concentrate the social sciences at universities other than Roskilde suggested the revised governmental position. Also indicative of the changed atmosphere at Roskilde was Tove Nielsen's laconic remark, when she was asked what she thought of Roskilde, "We have all heard something about Roskilde!"

Now, in the early eighties, the risk of unbalanced politicization of the universities no longer seems so threatening to large political milieu as it did in the late sixties and early seventies. Inge Bø observes (in the article referred to earlier) that to make the science or the didactic approaches servants of an ideology creates a situation hardly better than when the sciences acted as an *anquilla teologiae*, a servant to theology during the Middle Ages.

As the political climate around RUC is gradually becoming temperate again, this University Centre may very well win back its position as one of the outstanding driving forces towards interdisciplinarity in higher education in Europe.

C. The University of Linköping

The experiences of the University of Sussex (see below) and of the university centres of Aalborg and Roskilde (above) seem to have been of special importance as European references for the new Swedish university at Linköping. The experiences gathered during visits to these universities (and also to some American counterparts such as the University of Wisconsin at Green Bay) are recorded and interpreted by the groups of visitors. Some of this material is drawn upon in this report.[1]

The Linköping contribution to interdisciplinarity is important, both in philosophy and in practical terms. In this context, the theme model will be emphasized.

In a research context (which is the prime context to Linköping) the following claims are made:

- The theme should provide possibilities for research which is relevant to society.

1. Reports (in Swedish) of 1974 (Sussex) and 1976 (USA) are available at the University of Linköping.

- The research within the theme should have scientific significance.
- The activity within the theme should be of relatively long duration.
- Contact with research should be possible also for undergraduate students.
- Education of researchers should be provided within the theme.

Within this concept it is almost a "must" that any given problem be formulated from the viewpoint of several disciplines. Thus, researchers with a variety of disciplinary backgrounds have to cooperate from the moment that the problem is defined and throughout the solving process. The experience gained at the University of Sussex indicates that such researcher teams should be composed of no less than five and not more than ten persons.

This organisation in themes and researcher teams is judged to be well in line with the government instructions formulated for the university in 1975. According to these articles of instruction, the organisation should:

- be interdisciplinary and thematically oriented
- be built, not on a strict demarcation of subject fields, nor upon permanent subject teaching-posts
- be a valuable complement to the traditional university organisation, thus making it easier to satisfy the new interdisciplinary research requirements.

The university looks upon broad problem areas or themes both as points of departure and as unifying elements. The main idea is that each theme should be formulated at a relatively high level of generalisation. It is important to note that the potential life of a theme should also be long, making it suitable as a starting point for a permanent, yet flexible, type of research. This organizational model is typical in the sense that the themes themselves give rise to the departments that will gradually come into being: one department for each of the four themes. To begin with, there should be a joint department for the themes.

It is interesting to note the composition of the planning body for the theme activity. This council has an important part to play as it allocates the money allotted to the research programs on the basis of an annual application; it also provides a continuous five-year plan after a budget "dialogue" is held between the council and the themes, and it comes up with a staffing plan for the entire organization. The underlying principles are:

- the theme council must have a qualified scientific majority dedicated to maintaining scientific standards
- an external majority as a stimulus to change, and theme research workers who are allowed to exercise considerable influence. The result is that three categories have a representation of 1/3 each, namely

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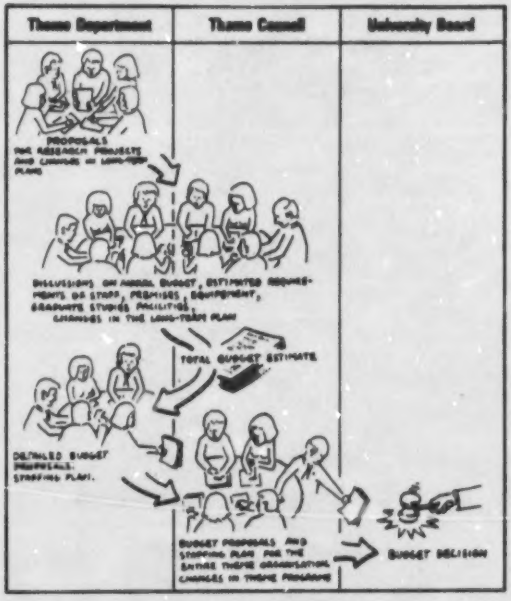
a. researchers from the theme departments
b. other researchers/scholars
c. interested external individuals.

Thus, the contact links with the scientific community at large, with the region, and with society in general are all taken care of through the composition of the theme council.



It is of utmost significance that the positions to be filled are not tied to disciplines or subjects, but rather to theme programs! The plan is to have four or five full professors and a corresponding number of associate and assistant professors in each theme. Guest researchers, documentalists, and people normally engaged in the administration of industry will, it is hoped, also participate in numbers above the average for Swedish research organizations.

In each theme, Linköping university now has (1982) between fifteen and twenty professors and Ph.D. students, and is planning to increase the number of students by five or ten per theme each year during the current five-year planning term. As a medium-sized university (1550 employees and 7700 students in 1982), Linköping finds it difficult to provide a sufficiently varied range of courses for doctoral candidates. The solution to this problem might be to bring about a number of exchange agreements with other universities. Then the Ph.D. students of all the participating universities would profit by a wider

range of courses, each given for a certain period of time. It is foreseen that, for the Linköping students, the courses taken at some other university could even be at the expense of the theme involved.

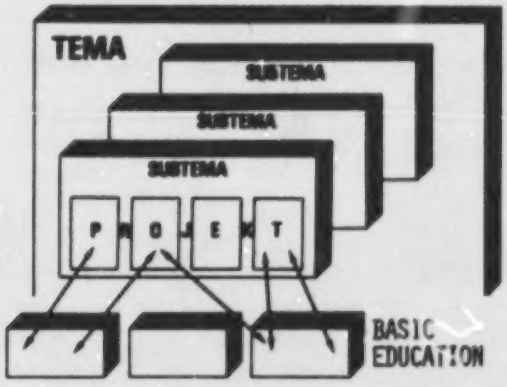
Another special feature is the Linköping concept for combining theme research and undergraduate education. The most interesting features are:

- Towards the end of certain degree courses, the theme department initiates and leads sub-projects. These projects overlap the subjects involved completely or partially.

- The theme department itself provides courses and makes them available as separate options or as part of the established course structure.

- Teachers taking part in undergraduate education participate on a full-time or part-time basis in research projects within the theme. They may even be linked to the project as specialists.

The theme model and its relation to undergraduate education is illustrated like this in the publication Tema, Ny väg för forskning. (Theme for Basic Undergraduate Education):



As indicated above, the theme is the body for allocation of resources. In line with the program budget system, applied resources are transferred from the Ministry of Education and Science to the themes and other program areas like Medicine and Technical education.

Obviously, it could be seen as a dilemma that undergraduates at Linköping University are as discipline oriented as

they are. For the sake of interdisciplinarity, it is to be hoped that they will gradually move in the direction of a more problem-oriented approach. This is generally recommended in Sweden by Riksdagen (Parliament) for all the universities. The Danish experiences at Aalborg and Roskilde and the corresponding efforts at Norwegian regional colleges (see above) also confirm that there should be a close link between undergraduate education and research, not just between research and post-degree courses. In the long run, such a policy will also stimulate the education of problem-oriented researchers, a category which is very vital as a problem-solving resource in our increasingly complex societies.

It is interesting to see how Linköping University selected its themes. A large committee composed of members from Swedish, German, and Norwegian universities, in cooperation with the Swedish Committee for Future Oriented Research, came up with the initial proposals. These were then elaborated further by special national work groups with a mandate to develop proposals for specific long term programs. This effort was made during a period when comparatively bigger shares of government expenditure on research started to go in directions other than the universities. More and more went to applied research performed through external bodies. Question marks appeared uncomfortably often behind queries about the relevance of the on-going research to society. Observations were made to the effect that extensive and complex problems needed coordinated research. It was felt that ever so many urgent problems had been left stranded between areas of academic competence. No one had the resources and energy to bring them into the sphere of research. The establishment of a new university provided a unique possibility for a reorientation which could hardly be expected on such a scale in institutions where the vested interests of the disciplines all too often create structural obstacles to change.

The recipe thus prescribed for the University of Linköping was the following:

In the place of research organization based on the disciplines, broad problem areas, or themes should be the points of departure and uniting elements. Each theme should be formulated at a relatively high level of generalization, based on the needs of society, rather than on autonomous academic needs. A theme should have a relatively long life potential, but it should still be possible to wind it up or give it new content. Thus, the idea was that themes should be the starting point for a permanent but flexible research organization. The framework should be designed in such a way that it encourages and does not obstruct the crossing of boundaries between disciplines. This is essential to theme activity when it involves working with problems and identifying and generating new ones. The activities within the themes should be capable of influencing in an interesting way education both for research and at the undergraduate level.

To summarize: Each theme is to be oriented towards problems in socially relevant areas, to provide opportunities for interdisciplinary and multidisciplinary cooperation, and finally to stimulate the development of theory and methods.

It was also pointed out that even wider perspectives were needed. Universities would work in the direction of uniting, for example, technical subjects based on the natural sciences with both the social sciences and the humanities. As efforts made to develop interdepartmental or sectional research in traditional institutions of higher education were obviously insufficient, universities hit up on the theme idea described above. The four themes chosen and now in operation are the following:

Health and Society

Communication

Technology and Social Change

Water in Environment and Society.

Health and Society:

In the essay "A New Path for Research, Themes at the University of Linköping," it is noted that

> From an international point of view there has been a growing interest in the contributions of research involving cooperation between medicine and various behavioural and social sciences.
>
> Social medicine has developed, in many contexts, in an interdisciplinary direction. In American universities one often finds Institutes of Public Health or Health Administration and Health Economics with a strong social science bias. Epidemiological studies are developing into broader social science studies.
>
> A theme concerned with health and society provides a fine opportunity for cooperation with a new medical faculty which has a pronounced clinical bias. Access to the large modern regional hospital and the county administration facilitates comprehensive empirical studies.
>
> It should be emphasized that the intention is not to compete with the planning bodies and planning institutes already existing within the public health sector but that the theme should function as a scientific complement - for example in the development and criticism of methods and theories.
>
> Examples of problem-areas within the theme are: *The Health Organisation in Society, Problems of Information and Contact* and *Health and Social Environment.*

Communication:

> Human communication is the research field of the Department of Communication Studies. A central area is the study of linguistic communication, both in spoken and written form, but communication through non-verbal signals, pictures, and other media, as well as the interaction between such different communicative modes, are also important issues.
>
> The production, interpretation, and understanding of messages, in relation to different social settings and experiential attitudes, is a major research focus. Different functions of communication are studied: conveying and acquiring knowledge and attitudes, establishing social bonds or social barriers, marking social and cultural identity, expressing and perceiving messages in the arts.

The conceptual framework for the research is the dependency of man, both as an individual and as a social being, on communication processes in a broad sense. A main goal is to increase our understanding of how we interpret and react to different kinds of information, and how integrity and initiative can be maintained within the complex social systems of modern society. Such knowledge is an indispensable foundation for the activities of the mass media, authorities, educational and cultural institutions, as well as individual members of society.

Important areas in this context are:

- general communication theory, including comparative studies of different means of communication (written and spoken language, non-verbal communication, pictures etc.) and the relationships and interaction between these;
- communication by speech and other means in discourse and face-to-face interaction;
- communication by writing, pictures, computers and other technical means;
- developmental aspects of language and communication;
- disturbed and incomplete communication and compensatory strategies;
- historical aspects of socially and culturally related patterns of communication, their appearance, transmission and change under different environmental and social conditions;
- communication in socialization and education;
- interpretation and understanding of literature and art.

Technology and Social Change:

The title "Technology and Social Change" implies that research should comprise the study of various social phenomena as a function of time - diachronic research. The investigation of changes in the past can provide points of departure for the study of future changes. In addition to such research, structural or more synchronic studies should be made of contemporary social problems in the area of the theme.

An essential task for the theme is to accumulate and develop a more general knowledge and new theories of technology and social change, taking into account both international research in the field and current debates and investigations. The daily conduct of the research activities within the theme could be structured according to various principles, but should permit different fields of research to develop distinct from each other. The research should concern itself with various macro and micro aspects of social change such as technology and work; the growth, dynamics and control of technology; technology and social structure; technology and culture. These are not only important dimensions of the total research work of the theme, but the titles of the four major post-graduate courses and workshops offered by the theme within a 2-year-cycle.

Water in Environment and Society:

> Research and research training within the theme take up problems from several areas, and these can be summarized under the headings, *Natural Resources* and *Societal Development*.
>
> The heading *Natural Resources* embraces among other things biological, chemical and hydrological processes. This can be connected with *Societal Development*, by which is meant the shaping of society and the consequences of such shaping for a region as well as for the individual. *Planning* is something that cuts across both of these headings. When water planning and the management of land and water is involved, both chemical and biological aspects must be weighed against political, cultural, economic, administrative, and legal aspects.
>
> Activities are concentrated on developing long-term research programs which contain a number of research projects. To the greatest possible extent these programs contain relevant elements from the headings described in the previous paragraph. In focus are three programs, two of these oriented towards problems considered important in Sweden and one towards a developing country.[1]

D. **The Bielefeld Center for Interdisciplinary Research** (ZiF)

An interesting feature, and probably an absolute requirement of the Bielefeld experiment in interdisciplinarity, is that it was established previous to the other faculties of the University of Bielefeld as a Scientific Centre of the university. It thus had a decisive role in determining the structural make-up of the university as a whole. Yet ZiF is a university institute and, as such, an integrated part of a combined pedagogical and research effort. In line with professor Vosskamp's presentation at the Bucharest symposium, the organizational framework deserves attention as it allows two forms of activity:

> First, during each academic or research year, there is at least one research group engaged in studying an interdisciplinary theme. In recent years, for example, there have been groups dealing with "Mathematical Problems of Quantum Dynamics," the "Early Development in Animals and Man," and "Properties and Reactions of Isolated Molecules and Atoms." Last year we examined the "Functional History of Literary Utopias in Early Modern Time" and "Social Therapy Institutions in the Correctional System". Currently ZiF is hosting a research group on the "Guidance, Control and Performance Evaluation in the Public Sector," and future projects will relate to "The Probabilistic Revolution" and "Many Degrees of Freedom in Mathematics and Physics."
>
> The research groups consist of about fifteen scientists from different disciplines and countries who usually take up residence at ZiF with their families. The preparation and holding of a research group always requires an extraordinary amount of organizational work on the part of the project director. Some form

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1. See discussion in "A New Path for Research Themes at the University of Linkøping," (1982), Linkøping.

of harmonization has to be attempted, taking into account not only the discipline-related knowledge and interests of potential group members, but also the different national and social conditions of their previous positions, in order to create an atmosphere in which an interdisciplinary dialogue can take place. In addition to the regular seminars and colloquia, ZiF has therefore found and developed a number of possibilities which facilitate informal contacts and these have contributed considerably to the success of past research groups.

The second form of activity developed by ZiF to encourage interdisciplinary discussions is workshops. There is a need to react relatively fast to topical scientific problems and newly emerging relationships between the disciplines, and ZiF responds to this challenge by organizing every year up to thirty workshops (with twenty to sixty participants) which last from one to five days. The themes and working-plans are interdisciplinary in character as in the research groups. The entire organizational preparation as well as the management of the workshops is undertaken by ZiF.

Applications for interdisciplinary workshops to be held at the Center have now reached a number which cannot be handled within the existing framework of financial, organizational, and staff resources available to ZiF. This has created a subsidiary task for ZiF, which is a difficult one, namely the question of planning and deciding which workshops are to be given.

As a forum for short- and long-term workshops and research programs, ZiF has the following main function:

1. Interdisciplinary mediation between individual disciplines to encourage interdisciplinary solutions to problems and formation of syntheses and feedback mechanisms for individual scientific disciplines. The preference is for the discussion of questions which do not fit into the traditional disciplines and for which traditional methods of study have so far been inadequate.

2. Mediation between theory and practice by encouraging basic research as well as practice-related research, such as that seen in the ZiF research groups on "Quantum Dynamics," "Behavioral Developments," the "Organizational Forms of Modern Business Enterprise," and the current group on "Social Therapy Institutions in the Correctional System."

3. Mediation between science and public life

   a. by addressing the international community of scientists and inviting recommended scholars to the Centre and creating international interest for research projects;

   b. in relation to the academic community of the University of Bielefeld (on which ZiF has a bearing as one of the University's institutes) by contributing directly to research and teaching at the various faculties;

   c. in relation to a wider public in town and country who expect answers to existing problems which can only be formulated at an interdisciplinary level.

Professor Vosskamp finds that the following five points are of special interest in relation to the issue of interdisciplinarity:

1. The choice of the right time for an interdisciplinary research program.

   When organizing an interdisciplinary project which involves several disciplines, choosing the best time for holding the project is highly important. The contemporary situation of scientific developments in the area under review has to be considered. A certain level of maturity must have been reached in the various disciplines involved in the project. The overall profile of contemporary society or what goes on outside of science must also be considered in planning, because only a specific disposition by society towards specific questions offers the prospect of success to a project which might otherwise be doubtful.

2. The identification of an appropriate subject area.

   For successful completion of an interdisciplinary research project, strict selection criteria have to be applied when deciding on the subject area of the project. It would have been an impossible task to undertake a global study of the subject of "Utopia" since this would only have produced mediocre generalizations, and no concrete scientific findings. For this reason, the genesis of literary Utopia in early modern times was chosen for the Bielefeld project on Utopia with the aim of having a subject area which was defined, limited, and thus more suitable for scientific scrutiny. In spite of the temporal limitation, a considerable amount of discipline was still required to restrict discussions within specified boundaries. Special emphasis was therefore placed on the functional aspect.

3. The necessary limitation of the complexity of a particular interdisciplinary problem requires a language suited for practical research and in which the various scientists can communicate beyond the level of their own specialized language.

   All scientists participating in an interdisciplinary research project initially express themselves in their particular discipline-related idiom. Gradually, as research activities progress, a "mixed language" (Mischsprache, Lars Gustafsson) emerges as a result of a learning process which contains elements from the various discipline-based languages. In the course of the research process, this mixed language must become a 'synthetic language,' with a certain degree of abstraction, to enable a mutual communication. A 'philosophical' language which is too abstract should nevertheless be avoided in order to ensure that, within historical research, concrete work remains practicable. Communicability is also important because research findings have to be communicated to practioners in other areas of academic and public life.

4. The synthetic language developed during interdisciplinary research activities constitutes a new scientific discourse and thus opens the way for a new discipline.

   The constitution of a scientific discourse based on a synthetic language developed in an interdisciplinary research process underlines the fact that only a spoken scientific language enables the creation of a scientific

discipline. Interdisciplinary and discipline-related research is characterized by different institutionalized forms of speech. Only when scientists engaged in a particular research identify a language suited to their subject can science constitute itself. In this way, our research group on Utopia found that, toward the end of the group's activities, the perspective of a new discipline emerged which we then termed "Utopieforschung" (Utopian research).

5. Group-psychological processes are also an important factor in the success of interdisciplinary research. The dynamics of group-psychological processes are closely tied to the learning process in terms of a reciprocal exchange and developing a common language for the purpose of constituting a research subject and even a new discipline.

Professor Vosskamp concludes with four points he considers important for an interdisciplinary theory. These points will be considered in the chapter on strategies where we shall see that three of them may be universally acceptable while the fourth has been disputed in some quarters.

It is interesting to note that not only the Centre at Bielefeld but also several other institutions in Western Germany are engaged in interdisciplinary research. Some are independent of the universities, such as:

1. The Mathematical Research Institute in Oberwolfach
2. The Herzog August Library in Wolfenbüttel (cultural history of early modern time)
3. The Historisches Kolleg in Munich (interdisciplinary studies in historical research)
4. The Wissenschaftskolleg zu Berlin (modelled on the International Institute for Advanced Study in the United States).

Other examples given by Professor Vosskamp were research projects of The Max Planck Institutes: research related to The Baltic Sea Region in Kiel, to mathematics in Bonn, to history of the 19th century in Bochum, and finally to the social history of German literature from 1770 to 1900 in Munich.

E. The University of Sussex

The Sussex University experiment in interdisciplinarity is interesting because it contains striking examples of success and failure. The several features of the interdisciplinary effort at this fairly new university are widely known and have thus served as a frame of reference for other universities, for instance Linköping. The value of the Sussex effort thus goes beyond the learning derived from the rise and fall of the initial experiment at the Brighton university itself. While the initial experiment there failed, it was compensated for through the obvious successes of the subsequent SPRU and IDS experiences. Quite a few hows and whys could therefore be posed. It may therefore be appropriate to deal with the course entitled "Contemporary Britain" and some of the activities which flourish at the Science Policy Research Unit and at the Institute of Development Studies.

In "The death of a contextual," W. Jago describes the history of the undergraduate interdisciplinary course at Sussex University and its subsequent decline.[1] The course entitled Contemporary Britain was a compulsory part of the degree course for students in the schools of English and American Studies and Social Studies. The course was based on the idea of "common studies in which all the different specialists within the school would share." Contemporary Britain involved topics such as contemporary British culture and society, demographic and social change, social problems and social policies, the instruments of social communication and their control. The course was taught to seminar groups composed of students from both schools with a range of different majors by a pair of tutors, one a literature specialist and the other a social scientist. The course failed, and the author outlines the following key factors in its decline:

1. disciplinary and institutional problems

2. the nature of the course itself, and

3. students negative perception of the course.

The author concludes that "interdisciplinary courses require higher investment of resources and commitment in order to survive, and that structural constraints and features must be a continuing concern of their proponents."[2]

The University of Sussex was inaugurated in 1961. Some of its initial characteristic features were:

1. specialization of the individual student was regarded as necessary, partly because students needed training in dealing with complicated problems and partly because society seemed to demand special knowledge of university graduates. Yet a narrow specialization was not looked upon as sufficient; students needed a certain amount of educational breadth. The three-year Bachelor programs were therefore composed so that half of the study time was devoted to special or disciplinary subjects and the other to interdisciplinary courses. The latter were supposed to provide the necessary overview even though they were closely related to the chosen disciplines. This does not mean, however, that the importance of breaking down barriers between, for instance, the human and the natural sciences was not appreciated. Still, there seemed to be a clear tendency to consider the interdisciplinary approach as primarily a pedagogical problem for the individual student. The organizational structure could support interdisciplinary thinking and study but could not force an interdisciplinary attitude on the students.

2. Research was concentrated in centres where interdisciplinary cooperation and problem-oriented activity could be pushed at the expense of traditional disciplinary research.

3. Decision-making was delegated as far as was possible. The result was an organizational structure which was quite complicated and required comprehensive internal communications and information systems. Discussion was also stimulated outside the

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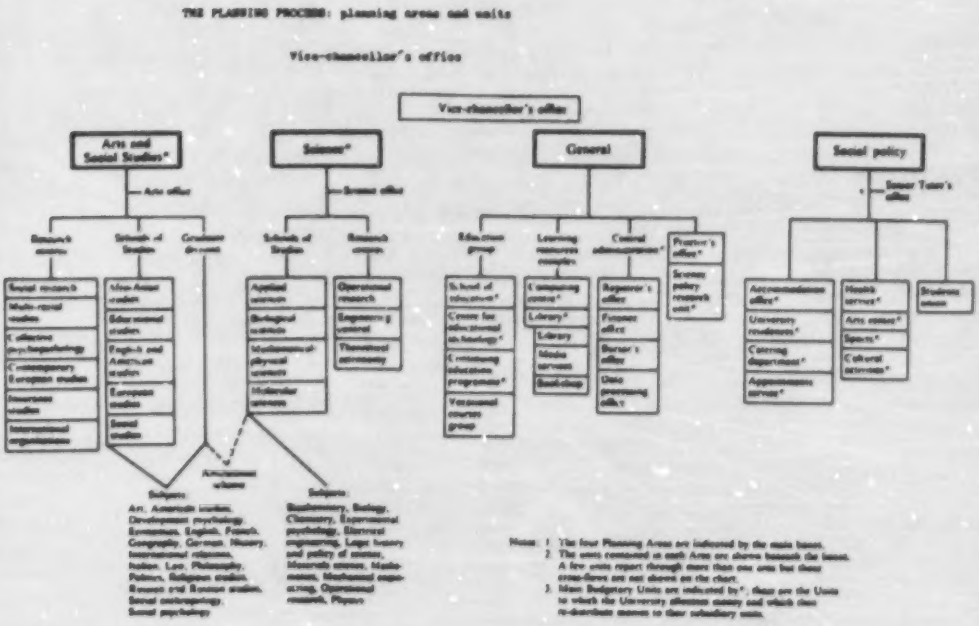
1. W. Jago, "The Death of a Contextual," Studies in Higher Education, 6(1981), 71-76.

2. W. Jago, Ibid.

formal decision-making system to enable the individual "schools" to react flexibly to new ideas. The formal system contained a number of planning areas and units at different organizational levels, as illustrated by this chart:



The Swedish study group visiting Sussex University in 1974 found it interesting that, the obligatory preliminary course or "school study" of the first year of the School of Social science was Aspects of Modern Industrial Society. The course dealt with theory and methods in the social science and endeavored to analyse the structure of modern industrial society, comparing the economic, political, and sociological aspects of the Western industrial system with its East-European counterpart.

The second and third years of study were shared between special studies and contextual courses. The main topics of the special studies were:

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- Social Anthropology (1)
- Economic History
- Economics (2)
- Economics with Mathematics
- Geography (3)
- Geography with Mathematics
- History (4)
- International Relations (2)
- Law (2)
- Linguistics
- Philosophy with Social Science
- Politics (3)
- Social Psychology (1)
- Social Psychology with Mathematics
- Sociology (3)

The numbers in parantheses indicate at how many of the four other schools the special area could be studied as a major subject.

Every student of the School of Social Science was required to take two out of nine optional contextual courses, such as Decision-making and Conflict Theories, Social Currents and Political Patterns of Action, Social Stratification (Distribution of power, influence and social prestige in modern industrial society), Advanced statistics or Economics. The two contextual courses obligatory for all social science students were Issues in Contemporary Society and Concepts, Methods, and Values in the Social Sciences. (The former dealt with a broad spectrum of social problems thus requiring insight into a combination of several social science disciplines).

The Sussex approach represented a major effort to introduce interdisciplinarity. However, already in 1974, on-going discussions revealed that a crisis might be imminent. Indications were:

- A demand for doing away with preliminary courses in the schools of natural science (e.g. the Unified approach to the fundamentals of biology course).
- The Common courses in Arts Schools faced a rapidly decreasing number of students which could cause a reorientation of the study plan.
- The interdisciplinary course which aimed at combining the arts and sciences was disposed of in Arts Schools.
- The relative importance of tutorials decreased as a result of diminishing resources.
- An increasing number of students left the university ahead of time.
- The integrated three-year study process was disintegrating and a modular structure appeared.
- Certain courses were no longer sought by enough sufficiently qualified students.

As previously observed, even the interdisciplinary connecting link par excellance Contemporary Britain (Culture and Society in Contemporary Britain) disappeared from the study

catalogue. The whole interdisciplinary effort invested in the undergraduate program was on the decline.

The research activity at Sussex University is performed partly through the respective schools and partly through the various research institutes. The graduate students take part in researcher teams. In principle, such teams may be disciplinary (or area) or interdisciplinary directed. In practice, the Swedish study team found that the research effort was almost exclusively disciplinary, with two important exceptions: IDS and SPRU (Institute of Development Studies, and Science Policy Research Unit). Apart from those, cooperation across the borders of the disciplines that could be described as interdisciplinary, or even multidisciplinary, was clearly the exception rather than the rule. The organization in schools did not seem to ease interdisciplinary cooperation either.

University spokesmen said that there were several reasons for the decline in interdisciplinarity over the years. Among the more important was the fact that the allocation of means for research projects followed traditional and conventional routes. If this problem could be improved, many researchers would no doubt change their disciplinary preferences, even if they all had been appointed on the basis of their own special disciplines with a primary responsibility to develop them. The individual researcher or researcher team could quite probably fall between chairs when running the risk of engaging in an interdisciplinary problem area.

A complication arose because the university library, centrally placed on the campus, could not pay any particular attention to interdisciplinary requirements. Literature purchases were matters of decision for the respective schools and research institutes. In spite of the proclaimed policy of having one common library resource centre on campus, several institutional libraries had grown up quite independently even though there was a central budgetary allocation for library purposes. Responding to questions put by the Linköping study group, several researchers said that the institutional libraries only kept them abreast with new literature in their special fields. For in depth studies and more comprehensive book screening, they had to go to the British Library's lending Division in London.

As indicated above, the Swedish Study Group of 1974 found the SPRU and IDS institutes of particular interest in connection with studies preceding the establishment of their own experimental university. The Science Policy Research Unit was established in 1966, at the initiative of teachers of the university representing a wide range of subjects. The aim of the Institute was "to contribute to increased knowledge of the complex social process of research, invention, development, innovation, and diffusion of innovations, and thereby to a deeper understanding of policy of science and technology." Since 1971, social and technological forecasting has become a main task of the institute.

The work is organized in a number of problem areas (themes or programs) and divided into projects. One researcher may take part in one to three projects simultaneously, and five to eight

researchers are engaged in any one project. A reference group of twenty to twenty-five persons may also be associated with it. Professor Freeman, the founder and leader of SPRU in the seventies, was strongly in favour of the idea that a team of researchers should consist of the number of people that could be housed in a small room.

One problem was that it was difficult to get social and natural scientists to cooperate. Among other things they talked a completely different language at the outset. Another point often stressed by Dr. Freeman was that the term "Science Policy" was often misapprehended. A more correct impression of the SPRU activities would be conveyed by "Science and Technology Policy". The main interest of the institute was certainly directed toward policy for the professional research and development network and the way in which this social subsystem interacts with society as a whole. This interest includes both technological innovation arising from research and development and the narrower concept of science as fundamental research. It extends to the diffusion process of innovation in social systems.

According to professor Freeman, the SPRU institute was too dependent on external funding for its different projects. He was of the opinion that half the resources needed ought to be regular money and the other half allocations from research councils and contract money. As it was, most researchers were tied to SPRU for a restricted period of one to five years. This fact quite often hampered their activities during the final phase of their engagement and could also cause discontinuity. On the whole the organisation of research councils was a barrier to interdisciplinary research. The structure should be altered in order that problem oriented studies could be pushed rather than counteracted. The main reason why SPRU accepted money from industries was that effective research into contemporary policies for science and technology benefits from contact with real life problems confronting decision-makers in industry and government.

Another point of interest is the interchange between the university as a totality and its science policy unit. SPRU was said to have a collective teaching obligation toward the university. The size of it depended on the contribution of the university to its activities. The teaching load was shared between the people employed according to their competence, interests, time, etc. The teaching was ordered by the various schools for undergraduate and graduate students. SPRU also took a responsibility for researcher counselling.

As the object of the SPRU research depends on a single all-embracing social system, it is engaged in the history, economy, sociology, and 'policy' of science, technology, and innovation. A close cooperation between social scientists, natural scientists, and technicians is therefore a necessary prerequisite for good results in the various fields of research.

It is impressive to see the extent of the teaching effort undertaken by an interdisciplinary research institute like SPRU as early as in 1973.

A. Undergraduate:

School	Course Titles
Afro-Asian Studies	Science, technology and development
Applied Sciences	Economics of innovation; European technological co-operation; science policy; industrial innovation; interpersonal behaviour; the engineer in industry
Mathematical and Physical Sciences	Principles and perspectives of science; social dimensions of science; science and the environment; economics of science and technology; social and technological forecasting; science, technology and development; contradictions of progress; the modelling process
Molecular Sciences	Chemical industry in the national economy; economic and social aspects of science
All Science Schools	Science, technology and the modern industrial state

B. Postgraduate:

Degree	Course Title
M A Development Economics	Technology transfer and choice of techniques
M A Industrial Economics	Economics of research and development
M Sc History and Social Studies of Science	History of science; science and institutions; science and public policy; science, technology and society; science, technology and development; science and government in the USA; science and government in Britain; science, technology and the human environment; economics of R & D; policies for science and technology in contemporary Europe
M Sc Control Engineering	Social and economic aspects of automation
M Phil Development Studies	Data use and techniques for development studies
D Phil Materials Science	Technology and international relations

C. Areas of research:

1. Social and Technological Forecasting and Technology Assessment

   i. Basic Work on Forecasting Methods

      a. Critique of Existing Techniques
      b. The application of Dynamic Analysis and Forecasting Techniques to World Problems
      c. Measurement of Attitudes and Values

   ii. Dynamic Models of Future World Trends

      a. World Population, Environment and Resources
      b. Feasibility Study for a Mathematical Socio-Economic Model of the EEC

   iii. Technology Assessment

      a. The value of Human Life in Consumer Safety Decisions
      b. The Energy Corts of Food Production
      c. Chemical Weapons and Chemical Disarmament
      d. Prospects for Health in Rich and Poor Countries

   iv. Strategic Developments Affecting the Long-Term World Energy Situation

   v. Technological Change and the Demand for Manpower in the Engineering Industry

2. Science Policy and Developing Countries

   i. Science and Technology in China

      a. Policies for the Promotion of Technological Innovation in Chinese Industry
      b. Internal Transfer of Technology in China
      c. Health Care in China

   ii. The Transfer of Technology to Manufacturing Industry in Thailand

   iii. Theoretical Work on Choice of Techniques

   iv. The Role of Machinery Supply in the Transfer of Technology

   v. A Study on the Use of Second-hand Machinery in Kenya (joint IDS/SPRU project)

3. Research and Innovation in Industry

   i. Success and Failure in Industrial Innovation

   ii. Comparative European Policies Towards Industrial Science and Technology

   iii. The Implementation of Innovation at Harwell

4. Historical Studies of Science and Science Policy

i. The Anatomy of An Elite: The Natural Science Tripos and its Graduates 1850-1919

ii. Research Aids in the Social History of Science

The SPRU effort will be dealt with in an extended perspective later on.

Being the national British centre concerned with the development of the Third World, the Institute of Development Studies (IDS), U.K., engages in three main activities: research, teaching and operational assignments.

Research is organized in problem areas. Until recently these were:

- Human Resources - population and development, manpower planning and employment questions, industrial relations, education and employment, health, and the role of women in development.
- Planning and Government - training in public administration, planning and public accounting, statistical priorities, access to public services for the least privileged, basic needs strategies.
- Rural Development - rural poverty, comparative village studies, crop storage, irrigation and rural development management, rural and agricultural technology and its economic, social, and political impact.
- International Problems - technology transfer, multinationals, foreign aid, inequalities and asymmetries in economic and political relations.

The Teaching Programme comprises short courses for government officials, senior personnel, and university teachers and researchers from developing countries, officials from developed country governments and international organizations working on development problems, and development workers in community and voluntary organizations in both developing and developed countries.

The main teaching activity is the study seminar, a four to six-week period of intensive and selective study for groups of fifteen to twenty participants from various countries, combining lecturing by specialists and practitioners, seminar discussions, field visits, and simulation exercises. Since 1967, more than one hundred seminars, attended by over 2000 participants from more than one hundred countries, have been arranged. An individual study fellowship programme provides particular officials and researchers the possibility to spend periods ranging from a few weeks to twelve months studying, reading, and writing in liaison with a Fellow of the Institute. A M.Phil. programme offers a two-year interdisciplinary post graduate course of twenty-four students from developed and developing countries with some practical and field experience of development work, and a D.Phil. programme, currently with some thirty full-time research students, complete the picture.

The component of operational involvement and consultancy work for Third World governments, international organizations, and development agencies in the developed world also deserves mention because it allows the staff to keep in touch with the realities of development work and to contribute to policy formulation and development strategy. One instance is the joint World Bank IDS study on "Redistribution with Growth" in the early seventies.

In a most interesting paper on the experience of the IDS (presented to the Inaugural Seminar, Zimbabwe Institute of Development Studies, Harare in March-April, 1982), Professor Carlos Fortin, then Acting IDS Director, quite open-heartedly dealt with change, continuity, and tensions of the UK institute. Professor Fortin outlined the following features which have been constant throughout the Institute's short history:

> Research feeds the teaching of the Institute, and has helped sharpen the individual character of the M.Phil. programme. It is also the basis on which operational work and consultancies build. Conversely, operational activities have interacted closely with research. As indicated above, three of the most important intellectual projects of the early 1970's (the ILO Employment missions) were commissioned studies, out of which came a whole body of thought that in some sense revolutionised the overall approach within IDS and outside to the meaning of development as well as raising specific questions on the informal sector and marginality.
>
> A second constant element in the Institute's approach is the interdisciplinary nature of its work. From the very beginning, the Institute was keen to look at development not only from the viewpoint of economists, but from a broad perspective that would incorporate social, political, anthropological, and cultural elements. Both the recruitment of staff and the organization of the work of the Institute have been geared towards this goal of interdisciplinarity.
>
> Posts have been defined broadly and the ability to work with practitioners of other disciplines (as well as to combine research with teaching and consultancy work) have been used as central criteria. The work has not been organised along disciplinary lines but in terms of problem areas that would cut across disciplinary boundaries.
>
> A third constant element has been the autonomy of the Institute in its relationship with both government and the University of Sussex. Whilst over half of the finance of the Institute is provided by the Overseas Development Administration, the government has no other say in the running of the affairs of the Institute than that afforded by the presence of government representatives in the Governing Body, the Finance and General Purposes Committee, and the Board of Studies.
>
> Finally, another constant feature of the Institute throughout its history has been its pluralistic orientation. The Institute includes within it a variety of theoretical, analytical, political, and ideological views, which nonetheless can co-exist in a creative dialogue.

Also, according to Richard Fortin:

1. The increased size of the Institute (130 employed in 1981) has made it more difficult to integrate work and has raised new issues concerning personal relations and management procedures.

2. The change in research priorities has been a source of continuous and at times passionate debate among members of the institute.

3. There are incompatibilities between field work for research and consultancies and continuing teaching loads. A recent proposal to separate organizationally the three functions of research, teaching, and consultancy and to assign Fellows predominently to one or the others was not adopted. On reconsideration, it was felt that the interaction among the three functions was too important to be compromised.

4. Changes in the teaching programme have also been a matter of controversy, in particular, the study seminar programme.

5. There has been a feeling among officials of the British Overseas Development Administration/Ministry that IDS's work is too academic or too radical to be of use to aid officials dealing with real life problems. IDS has countered by insisting that its role is not primarily to contribute to the day-to-day management of British aid and technical assistance programmes, but rather to help put the issues of the day in a wider perspective.

6. The risk that the Institute's work may become a disparate collection of individual research projects is a continual source of concern. On the whole, professor Fortin holds that the Institute may have erred on the side of allowing Fellows too much rather than too little freedom to define their work.

Obviously Dr. Fortin's comments on the interdisciplinarity of IDS will attract particular attention in the present forum of interdisciplinarians. It is therefore more than appropriate to wind up the current case study with his comments on this particular issue:

> The interdisciplinarity of the Institute has also been the source of some difficulties. Academic life in the U.K. and its ancillary activities proceed largely along disciplinary lines, and therefore there has been strong pressure from academic sources for the Institute to stick to more conventional terms of reference related to a particular discipline, rather than to follow a problem-oriented approach wherever it may lead. The Institute has resisted the temptation to fall into traditional lines; yet it has recognised that interdisciplinarity cannot be used as a pretext to disregard analytical rigour. This line of tension overlaps with another one: how much of the Institute's work should be devoted to the development of theory as opposed to the somewhat eclectic tackling of applied questions? Once again, opinions have differed; the Institute has nonetheless agreed to devote some of its resources to work on structuralist theories of the world economy and of alternative - neoRicardian and Marxian - theories of international trade.

F. The American Experience.

The Linköping University Study Group also called at a few American universities in October, 1975. Their intention was to discuss experiences derived from various efforts to organize interdisciplinary research and the linkage of these with undergraduate education. The institutions visited were the University of Wisconsin at Green Bay, the University of California at Santa Cruz and the Evergreen State College in the State of Washington. The group members also talked with representatives of the Bureau of Research at the State Department, the American Council of Education, the Council of Graduate Schools, the Brooking Institution, and the National Science Foundation. The impressions communicated by this study group will be described as indicative of the North American experience as will the contributions made to the Bucharest Symposium by professor Alger, to the Gothenburg symposium by professors Newman and Trow, and to the book on interdisciplinarity by Caroline D. Eckhardt referred to in this study.[1]

The findings of the Linköping study group follow below under letters A, B, and C.

a. UNIVERSITY OF WISCONSIN AT GREEN BAY (UWGB)

This university center of the University of Wisconsin System, caught the attention of Scandinavian planners and implementers of new models of higher education and research as early as 1971, in connection with the RUMO study which gave a detailed picture of the university, the ideas behind it, its goals, and structure. A principle of social responsibility underlies the University philosophy: the institution aims to educate socially responsible individuals to help create a socially responsible society. The intention was to accomplish this goal within the framework of one common perspective for the whole university: the human environment. For the individual, it was a matter of becoming fit to face the ecological crisis of the moment, irrespective of future employment.

From the outset the UWGB was organized in four colleges:

Community Sciences (CCS)

Creative Communication (CCC)

Environmental Sciences (CES)

Human Biology (CHB).

Every college had its own particular focus and a number of concentrations. Faculty were not engaged as economists,

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1. A Council of Europe Symposium in 1975, "Strategies for Research and Development in Higher Education". See also Council of Europe report by Noel Entwistle, University of Nottingham.

sociologists, etc., but, for instance, as Assistent Professor of Population Dynamics (a concentration). The institutional organization could be illustrated as follows:

College	Focus	Concentration
Community Sciences (CCS)	The role of men in the social environment and the processes by which they modify it.	The Modernization Processes Regional Analysis Urban Analysis
Creative Communication (CCC)	The dimensions of aesthetics and of values and some understanding of the ways in which they are perceived and transmitted.	Communication-Action Humanism and Cultural Change
Environmental Sciences (CES)	To develop the concept of ecosystems and provide an understanding of the exchange of materials and energy between living organisms and their physical and chemical environment, the use and management of natural resources, and alterations of ecosystems due to air, water and soil pollution.	Ecosystem Analysis Environmental Control
Human Biology (CHB)	Humans in relation to their environment	Growth and Development Human Adaptability Nutritional Sciences Population Dynamics
(School of Professional Studies)	Business or public administration Teacher certification	(Managerial Systems + four collaterals)

Every concentration is therefore the responsibility of a college and is constituted by a number of courses.

The recruitment policies for faculty have had a decisive impact on the chances for success or failure of interdisciplinary ventures. At UWGB, new faculty members got a three-year contract. Extensions or tenure were considered based on the following criteria: teaching ability, research activity, curriculum development, participation in liberal education seminars, and community participation.

The Swedish study group was much impressed by the care devoted to the organization of studies, recruitment, career systems, and the lay-out of buildings (with the big Library Learning Center in the middle of the campus). The group was nevertheless concerned about one fundamental dilemma: How could UWGB, with its national or even global orientation, meet its primary priority, of being a communiversity for its surrounding community? Would not this community always formulate its educational requirements in terms of traditional and well-known disciplines and evaluation criteria?

The links of the university with the local community were therefore a surprise to the Linköping group: The locally oriented projects were concrete, practical, and well adapted to student participation. The interdisciplinary research projects seemed to be related only to the four-year undergraduate education and not to the post-graduate studies. There was no Ph.D. program; it was even feared that such a program, if introduced, might be a conservative and hampering factor in the further interdisciplinary development of the university.

Of particular interest to a study of interdisciplinarity were the following features:

- Obligatory student participation in the liberal education seminars (LES), in all four years of study. While the LES programs were quite general to begin with, close contact with society and working life was generally established during the second and third year. During the fourth year, information acquired by students in many fields of study was pooled.

- A distribution requirement demanded that every student take at least five credits in each of the four colleges.

- The selection of a major at UWGB differed widely from the traditional. Here the student was required to chose either an interdisciplinary or inter-concentration option or a concentration option or co-major (Examples of Concentrations: Environmental Control, option chemistry-physics, Urban Analysis, option sociology).

- The student could also supplement his major program by selecting a vocationally oriented collateral or professional minor.

b. UNIVERSITY OF CALIFORNIA AT SANTA CRUZ (UCSC)

At the UCSC, the philosophy was that the theme-idea was to prevail: every college should be characterized by its theme. The university as such was only supposed to offer services to the colleges and to support their activities. The Linköping group found that development was not been up to expectations. Discipline oriented and discipline governed activities had gradually taken over, here and at another experimental University of California, namely Irvine. Everybody, including the Vice Chancellor, regretted this. Naturally the explanations are of particular interest to this study:

- External pressure from the established universities and the scientific society are always exerted against alternative models for higher education and research. Factors emphasized were the reward systems, the traditional philosophy, and the hierarchy of American universities.

- There was no academic plan that could be followed during the phase of implementation. The development depended upon the dominant view among faculty at any time.

- Recruitment of faculty was not based on a thorough discussion of basic criteria. Enough attention was not paid to how new faculty would match with the interdisciplinary goals of the university.

- Resources were not allocated to the themes only but also to discipline-oriented institutions. Faculty received their salary from a theme-oriented college as well as from a discipline focused institute, and thus teachers had double loyalties. In such a situation the discipline oriented loyalty might easily dominate.

- The themes were not developed to a sufficient extent, in part because every college had its own internal recruitment body. A precondition for change or modification of a theme would be that the governing body had an external majority, and that the majority of its members did not take part in on-going theme activities.

Despite serious backlashes for the theme model, spokesmen at UCSC told their Swedish visitors that they benefitted from better contact with other disciplines than was the case at any other university they knew. Such contact stimulated education and research. Theme oriented research also, had the potential to grant researchers greater freedom than its discipline-oriented counterpart. It would be helpful, however, if more research money could be reserved for collective research.

c. EVERGREEN STATE COLLEGE (ESC)

The Swedish study group found ESC of particular interest for several reasons. One was that its modular course system was only being used to accomodate part-time students. Ordinary full-timers normally alternated between the so-called coordinated studies and contracted studies.

One easily thinks of Roskilde University Centre after hearing that at ESC sixty to eighty students are taken care of by a number of faculty from different disciplines. The idea was to bring about close cooperation between students and their particular teachers. The system allowed the students to take responsibility for the work of the group. Another similarity to the Nordic experiments in interdisciplinarity was that the coordinated studies were organized within the framework of a central problem or theme. The aim was to get both faculty members and students involved in active discussion. Overviews, essays, sketches, draft reports, propositions, and even scenarios provided the basis for further discussion and coordination of work done by participants and made more refined results possible. Because of their close cooperation, faculty got a clear impression of the ability of every participating student. Traditional exams could therefore be eliminated, thus creating a better study milieu.

Normally a student or a group of students took a particular interest in a specific problem or problem area in the course of the coordinated studies program. A proposition for a contract study would then be made, and when accepted, sponsored by a selected faculty member. If several students participated, work was shared among group members after an initial period of common approach. Through this effort each student learned gradually to work independently of others. In addition the profile of his particular study was individualized. The Linkøping group reported the following example of a group contract on Peace Studies and Conflict Resolution: [1]

> I believe that conflict is inevitable in human affairs but that war is not. The goal of this group contract is to learn about how to resolve conflict, to learn how to work against war, and also to plan a coordinated studies program on this same topic for the following year. We will explore diverse areas:
>
> - the nature of war
> - aggression and violence in human behavior
> - the resolution of conflict between individuals and between states
> - the theory of nonviolent action
> - the practice of examples like Gandhi, King, Chavez, the Norwegians during World War II
> - violent and nonviolent responses by minorities and oppressed people
> - civil disobedience
> - dialectics
> - metaphor and art as conflict resolution
> - how to turn belief into action
> - what makes a good coordinated studies program.
>
> The group contract must function as an exploring and planning team where all members take a lot of responsibility. Students must be experienced and self-motivated. We must cover a lot of territory and report back to each other and to the faculty who will teach in the coordinated studies program.

1. Op.cit.

d. THE PENNSYLVANIA STATE UNIVERSITY

Just before the Bucharest symposium, the Director of CEPES contacted Professor Joseph J. Kockelmans at Penn State to hear his opinion on matters related to experimental interdisciplinary programs. Professor Kockelmans, who is responsible for the university's interdisciplinary graduate program in the humanities, told Mr Øfjord that their program, now in its tenth year, remains vertually unchanged in structure, despite efforts on the part of the funding agency and the University administration to translate the ideas about interdisciplinarity into organizational structures. In professor Kockelmans and his collaborators' opinion, the large universities in North America "have already more stable administrative and organizational units and clusters of units that are needed either for educational and research purposes."

At the time of the study, Penn State had more than 125 Ph.D. programs in different areas, most of which were interdisciplinary in some sense. According to professor Kockelmans, what is lacking in this and most other big units, is effective interaction and cooperation for purposes of education and research.

Right from the start of the interdisciplinary programs at Penn State in 1972, the focus has been on two major projects:

1. Introducing new courses and seminars in which faculty of different disciplines would effectively cooperate in discussing issues of a typical interdisciplinary nature.

2. Introducing faculty seminars in which faculty members located in different units, but with a similar or related research interest, could discuss on a regular basis, research projects in which they were already engaged, or educational issues which they believed of great importance. (Each year from four to six such seminars have been arranged, not all of them equally successful. The general opinion, however, seems to be that a meaningful contact has been established between faculty and graduate students who, working in similar and related fields, are located in different administrative or educational units).

At Penn State over the years more than fifty fellowships have been rewarded to graduate students who wished to work and study for one year in a department or program, different from, but related to, that of their major. Furthermore, each year a limited number of students study outside the regular departmental structure toward the Ph.D. degree in a field of their choice, but for which the university has no administrative unit. These students work under the supervision of a carefully selected group of faculty from different disciplines or interdisciplines, appointed by the Dean of the Graduate School.

The dialogue between the director of CEPES and his colleague in charge of the Penn State program on interdisciplinarity is of great general interest:

Øfjord:

Do you believe there is a need for greater interuniversity co-operation in order to provide better opportunities for students to attend courses in two or more institutions?

Kockelmans:

My answer to your first question is negative as far as undergraduate students are concerned. If we assume that all the students indeed went to the proper institution, then we may also assume that every 'good' institution will be able to take care of their educational, vocational, or professional needs on the level of sophistication that is characteristic of undergraduate education. As for graduate students, my answer is yes, at least in principle. Yet in different countries there will be different problems, particularly with respect to the economic support of these students. In the United States most graduate students have teaching or research assistantships because of which they must remain at their own universities. For our students this form of inter-university cooperation would work generally only where the geographic circumstances would permit it (in large cities and metropolitan areas).

Øfjord:

With respect to interdisciplinary studies, do you believe some alternatives of organizational forms are more practical than others? What should be the criteria with respect to organizational patterns?

Kockelmans:

My personal view is that too much organization and the administrative units which usually flow from such efforts are often real stumbling-blocks for genuine interdisciplinary efforts, both in education and research. Yet I should immediately add that in limited and carefully defined areas, such organizational structures and administrative units are often very desireable, if not simply necessary; such areas are found in both the 'pure' and the 'applied' fields of study, and particularly in the large areas of the vocations and the professions. In our discussions about these matters, we have often relied on the following metaphor: a large university obviously needs many buildings; but it is equally important to make certain that there are enough roads between them so that meaningful interaction becomes possible and a free flow of traffic is guaranteed. The latter has always been our only concern, leaving the construction of the necessary organizational structures to others.

Øfjord:

The level (year of study) at which interdisciplinarity is introduced may be different for different interdisciplinary fields, but articulation between generalist and specialized education becomes important. Should the generalist education always be first, i.e. the first years?

Kockelmans:

> In our own efforts we have always separated the concern for general education from the interest in interdisciplinarity. The reason for this is in part the fact that our program is a graduate program only. It seems to me that the concern for general education is to be seen in light of the ever increasing specialization in ever more limited fields of study, and the latter may be disciplinary or interdisciplinary in character. Furthermore, I feel that the field of specialization should be an important component of a student's education from the very beginning; yet during the first years of study and to some degree during the entire undergraduate curriculum, the stress should be on breadth (including general education), whereas in the last years and especially at the graduate level, the focus should be on depth, particularly in the field of specialization. I would also promote interdisciplinary interaction from the very beginning, but only where disciplinary work appears to be inadequate. In other words, I do not think that interdisciplinary efforts are a solution for all of our problems; generally speaking, I take them to be of dubious value in general education where pluri-disciplinary efforts seem to be more profitable.

Øfjord:

> Do interdisciplinary studies require new approaches for producing didactic materials? And is the use of modern teaching technology of particular importance?

Kockelmans:

> I do not have much to say about your last question, simply because I lack the proper knowledge and experience. From our own very limited experience I can say that interdisciplinary efforts usually succeed where very competent specialists are willing to cooperate in an attempt to deal meaningfully with an issue that ranges far beyond the competence of any one discipline or interdiscipline in the limited sense of the term. This seems to me to be true both for research and education. In our seminars and team-taught courses we usually try to show how each discipline has to reformulate the given issue in order to make it 'manageable' from its own perspective. We then discuss the limitations of the 'onesided' approaches. It is only at this point that interdisciplinary discourse becomes meaningful and relevant; this discourse is productive to the degree that the participants have respect for one another as 'specialists' and are willing to formulate problems and hypotheses which indeed are relevant to the issue under consideration. How all of this could be translated into new didactic material is a question which I am unable to answer.

By way of general comment, professor Kockelmans concludes the Penn State attitude in a way that characterizes the approach in a nutshell:

> We are convinced that, as far as our objectives are concerned, interdisciplinarity is not primarily an organizational or administrative issue, but rather an issue that is intimately connected with the meaningfulness and social relevance of education and research: thus it is an issue of mentality, attitude and 'philosophy'. Yet to avoid misunderstanding,

I should add to these that we obviously support all efforts (disciplinary and interdisciplinary) which are to lead to new organizational or administrative structures provided, they are relevant from an educational point of view. Yet the latter is not a task of our interdisciplinary programme.

•.

Another typical interdisciplinary experience is related by Prof. Alger. Professor Chadwick F. Alger joined the department of political science at Northwestern University in 1957. This department had then already made a deep commitment to bringing the knowledge of several disciplines to bear on the analysis of political phenomena. One first approach was to hire a carefully selected psychologist, sociologist, and anthropologist to join the department. Along with political scientists, these people played a prominent role in creating a new graduate program that drew heavily on the methods and findings of several disciplines. They also helped to build a community of social science scholars that transcended the department of political science, including primarily psychologists, sociologists, anthropologists, and political scientists. Professor Alger's contribution focused on the impact of changes in intergovernmental communications, socialization of participants and UN decision-making procedures. His work was performed within an interdisciplinary context, and it had a long-term perspective. His teaching was profoundly affected as he took an interdisciplinary approach to the United Nations and other international organizations. An undergraduate course he conducted in international organizations came to include a laboratory session each week in which members of the class played roles in a simulated international system.

A second main turning point in Dr. Alger's career started with his engagement at the Mershon Center, an interdisciplinary research center at Ohio State University. Inhabited primarily by social scientists, the center was devoted to policy research. A key goal of the center was to enhance the usefulness of research through improved procedures for direct contact of researchers with users. Professor Alger observed the powerlessness of local people to cope with the problems that affected them most: inflation, employment, energy, or global threat systems. The people were trapped in a cycle of apathy: because they had no knowledge, they did not participate; since they did not participate, they had no need to know; because they had no need to know, they were not interested; therefore, they had no knowledge. The belief was widespread that most people are not competent to understand international issues. An additional problem was a social structure that inhibited participation. Local communities were also deprived of their expertise through a brain drain. The few cosmopolitans who had left felt little responsibility for sharing their knowledge about the world with local people, or for supporting local programs that would extend local competence in world affairs. The underlying global socio-economic structure had placed them in a dependent status and walled them off from the world. Yet, in every community, numerous people performed dedicated work in voluntary organizations, such as youth and adult exchange programs, foreign aid programs, and educational organizations. However, their

efforts treated only the symptoms of maladjustment in the socio-economic structure through activities such as settlement of refugees, famine relief, and programs to deal with the consequences of poverty.

Professor Alger drew this conclusion from his interdisciplinary experience:

> Both my interdisciplinary and transdisciplinary experience have had distinctive impact on my contributions as scholar, teacher, and citizen. My interdisciplinary experience, a result of "internal push" from my academic milieu, enabled me to integrate knowledge from several social science disciplines and bring it to bear in research on behavior in the United Nations. This liberated me from the tendency of political scientists to treat "diplomatic" behavior as *sui generis*. The myths of diplomatic practice had infiltrated academic discourse. The concepts through which this behavior was perceived and studied by political scientists were largely created by diplomats. Scholars had accepted the special aura with which diplomats had surrounded their profession. They accepted the extension of myths about traditional diplomacy to behavior in permanent international organizations, largely through ascribing the label "conference diplomacy" or "public diplomacy" to this activity. But an interdisciplinary approach freed me from the language of diplomacy, enabling me to look at "diplomatic" behavior at the UN from the outside, rather than from the inside--inside in terms of a point of view strongly shaped by diplomats themselves. I was also freed to use a richer array of methods in studying UN behavior. And the audience to whom I addressed my writing was broadened to include people in several social science disciplines. But my audience still only consisted of scholars.
>
> My transdisciplinary experience was a result of "external push" brought on by perceiving things in the world that did not fit into my research paradigm. In response I tried to create a broader paradigm through intensive research on a multitude of ways in which my own community is linked to the world. The "external push" was intensified by emphasis in the research community in which I was working on interaction with research users, which in my case were people in my local community. Efforts to fulfill the knowledge needs of local people led to interest in the local community as a learning environment. The fact that people perceived their community to be peripheral, and dependent on centers for identifying international issues and for expertise on these issues was seen to inhibit local learning. This in turn was seen to be related to central government control over foreign affairs and the fact that voluntary organizations were organized in this same image. Thus, efforts to <u>directly</u> serve the international knowledge needs of local people not only extended research to the international links of the local community but to relations between centers and peripheries within the society.
>
> These personal reflections lead to two conclusions: 1. Disciplines can place great limits on the reality we are able to perceive. A factor in the definition of these limits can be the influence of those whose behavior is being studied on the development of a

discipline. An interdisciplinary approach can be very helpful in overcoming these restraints. 2. Disciplines can undermine the competence of people to cope with important public issues and can contribute to the creation of social structures that sustain their incompetence. A transdisciplinary approach can be very useful in overcoming these conditions, particularly when the people themselves are placed in the paradigm that guides inquiry.

What can we learn from this? The question should be posed whether one can share professor Alger's view that his interdisciplinary research on the ways in which the local community is linked to the world in turn could lead to a transdisciplinary inquiry into how a society is structured to deal with external affairs? Is it legitimate to share his optimism?

Bearing in mind the definitions of interdisciplinarity and transdisciplinarity in chapter 3 and applying these terms to the process so interestingly described by professor Alger, the answer will probably depend on the degree of utopism one associates with the latter term. The view of the writer is that prof. Alger seems actually to have found a way to transcend the borders of interdisciplinarity, and that his approach may serve as an illustration of benefits one can reap from similar approaches in the future. And this particular example was also selected because its theme is of such great impact to us all as members of the international community we call the United Nations.

f.

Is there some sort of common experience to be crystallized from the case studies dealt with in the current chapter? There seems to be one which is so universal that it finds consensus wherever it is felt. The Linköping study group put it this way:

> One has always had a tendency to try out new things on a too modest scale. A small scale involves the risk that the attempt fails at an early stage without having had a real chance. An obvious drawback of small-scale efforts is the lack of a sufficient number of spokesmen.

Though the majority of projects may be small-scale efforts, they seem to have caught the attention not only of the educational and research community, but also of builders far beyond this community. The examples of successes, near-successes, and partial failures presented here were to some extent chosen accidentally. Other examples might have been just as illustrative. Among these are examples of successful interdisciplinary research at Stanford, the good work done at the Centre for Multidisciplinary Studies in Dubrovnik, the keen efforts made at the Universities of Keele (UK), Naples, Syracuse (Italy), the National University of Australia, etc. Some of these efforts are indirectly represented in this study through available background material or even by quotations from their ideologists and supporters. Their importance as vital resource Centres and partners in the continual process of forming the strategies for the future of interdisciplinarity should not be forgotten.

5. OBSTACLES AND DIFFICULTIES

There are of course a lot of obstacles and difficulties involved in almost every context in which interdisciplinarity is attempted to be introduced. Examples of frictions or stumblingblocks were put forward by the CEPES symposium participants and are also well represented in the literature on the subject. The following may serve as warnings concerning representative obstacles, and deserve to be dealt with in some length.

From the Scandinavian debate one easily recognizes these factors which are probably quite universal:

First, there is the barrier of education. The education of faculty at first and second degree levels usually implies a socialization to disciplines and professions. This socialization tends to narrow their fields of knowledge and to hamper communication with people of other professions. Third degree doctoral studies tend more often than not to work in the direction of further contribution to knowledge in one specific discipline. The corresponding socialization may again have a conservative influence. One important sub-problem here is that discipline oriented researchers and educators tend to have different basic attitudes toward their respective research methods: this state of monodisciplinary isolation may even lead them to suspect each others scientific habitus.

Second, the organization of universities and colleges of higher education in departments, according to discipline oriented criteria, normally tends to hamper interdisciplinary communication. Departments represent disciplines: They may claim to possess a monopoly of expertise and look upon "outsiders" as a challenge. It is maintained (for example at the Gothenburg symposium)[1] "that the autonomy of the university itself is based, to a very large extent, on the aggregate claims to special expertise on the part of its departments." If this attitude is taken, it is indeed difficult to establish interdisciplinary co-operation with other milieus. Occasionally, a tendency to monopolize a given area of study or a study program may make even limited cross-disciplinary co-operation inside one single college impossible.

At the individual level the impetus to take part in interdisciplinary activities is still weakened by a hard-dying tradition for individual achievement. The main object may be to seek recognition among colleagues, preferably inside one's own department or institute. Fortunately, there are indications of a change here, although a performance based on one's own specific discipline is generally the main road to success. To harvest merits on the basis of interdisciplinarity seems even today to be only an alternative, and often a delicate, procedure.

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1. A Council of Europe symposium, 1975, on "Strategies for Research and Development in Higher Education," see CE report by Noel Entwistle, University of Nottingham.

Fourth, interdisciplinary study programs and research projects tend to suffer for financial reasons. The internal mechanisms for allocation of resources inside institutions are more often than not discipline-oriented. Unfortunately, this is particularly the case when resources are scarce, as in the current situation. Some countries even seem to lack procedures for a satisfactory treatment of interdisciplinary research projects, even when the processing takes place in research councils or institutes outside the university system.

Last, the contact links between the institutions of higher education are still too weak. Better connections will normally create a stimulus in the direction of interdisciplinarity. The experience gained with the Danish university centres and the Norwegian district colleges demonstrates that students can be highly in favour of interdisciplinarity provided they are represented in the relevant steering bodies and can exert a reasonable amount of influence.

The Bucharest symposium participants were well aware of the significance of having in mind possible negative features of interdisciplinarity and, where legitimate, of finding ways of counteracting them. If this approach is not chosen, a good cause could very easily be compromised. At the Gothenburg symposium,[1] Martin Trow put forward especially relevant counter-points which could serve as reminders even to the most ardent adherents of interdisciplinarity. In the current context, these cautions may also be categorized as obstacles or difficulties:

- Interdisciplinary programs require a large measure of consensus regarding what knowledge is most valuable.
- In addition, such programs make very large demands on the time and energies of their staffs.
- Very few academics are first-rate interdisciplinary teachers.
- Such courses often descend to the lowest common denominator of relatively uninformed discussion among teachers and students, none of whom has a solid mastery of the topic or its problems.
- When difficult problems arise, the tendency of such courses is to look at the matter from yet another perspective rather than confront the difficulty head on.
- The difficulties at the boundaries between disciplines are, of course, enormous.

It is not easy to strike the right and viable balance between the need for internal autonomy and the need for response to the requirements of society. Autonomy implies self-discipline. At the Gothenburg conference, Frank Newman posed the question,[2] "Are there many cases where faculties have in fact self-disciplined their members?" He answered the question

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1. Op.cit.
2. Idem.

himself by saying, "You know, and I know, hundreds of examples where faculty members have acted not simply irresponsibly, but disastrously." No doubt, there are people around who are inclined to share his assessment "that faculty and students have suffered badly enough in many conventional departments" and that "autonomy is important, but it must not be used to avoid answering hard questions or as a cloak to hide inefficiency." Indeed as institutions of higher education and research increasingly involve every facet of life and, in addition, are great consumers of public money, the call for accountability and insight from their environment and users, is not irrelevant.

This said, it is also important to say that academics have a legitimate right to an environment favourable to the pursuit of knowledge and, under no circumstances should such work be politicized. Many reforms aimed at producing a well-founded and desirable interdisciplinarity, do and will take place inside the academic community on its own initiative.

In recent publications on interdisciplinarity the following obstacles have been enumerated which confirm the general impression that it takes a very persistent effort to overcome current reluctance:

1. Student majors have a tendency not to take advantage of more flexible degree programs to go out of their basic disciplines. When they do spend hours outside their departments, they do so mostly in related disciplines. (Nadia Assimpoulos and Charles Belanger, about The University of Montreal).

2. Unfortunately, with its multiple definitions, interdisciplinarity in education confuses and poses problems for administrators attempting to implement new approaches. (Tom Connelly and Dan Clark).

3. In taking science courses for non-science majors, students are faced with the difficulty of adjusting to an entirely alien language and logic. (D.A. Labianca and W.J. Reeves).

4. Scientists have difficulties in relating their research oriented skills to the complex inter-disciplinarity found in industry. (Donald Leach).

5. Interdisciplinary research in the university setting is difficult to develop because the motivating factors for interdisciplinarity are powerful in society at large but weak within the academic community itself. The possibilities of changes in the university reward system that would promote inter-disciplinarity in the future are slight. Both external and internal conditions are decidedly less encouraging than they were in the mid-1960's. (G.W. Leckie, University of Manitoba).

6. An early introduction of interdisciplinarity is most likely to cause methodological confusion among students. (Frédéric Mauro).

7. The volume of material is too large, and attempts to cross-disciplinary boundaries carry with them the danger of superficiality. Many students lack background in the various disciplines to be integrated. There are also ideological problems concerning the general attitude among faculty who are specialists to insist upon their respective disciplines and let students find for themselves relations to other disciplines or problems of study. (Laurie Moseley).

8. When a student chooses his field of study, he most often seeks a traditional subject with a definite programme of more or less traditional content. A student often likes to know what the studies are about and that they will lead to a particular qualification which will give him certain privileges and rights in the job market. (Edmond Nicolau).

9. Faculty members are discipline-oriented, and their careers depend largely on their scientific achievement. Their motivation for interdisciplinary research and teaching or for participation in an interdisciplinary team is generally low, because little institutional incentive is provided in this respect. They are accustomed to enjoying a high degree of independence in their didactic and research activities in their respective disciplines and often find it difficult to adjust to team effort, in which each member's research depends to some degree on the work and research results of someone else. (A. Øfjord, Director of CEPES).

10. Within the university, education as a rule has little status. The career of the university staff is generally exclusively based on its performance in the field of research. The teaching staff is not prepared for its educational task. Therefore it is neither concerned with nor interested in teaching. Because of a lack of adequate preparation for their educational tasks, literature on the subject of education and educational innovation remains relatively inaccessible to staff members. The function of research in the field of education is not recognized or properly valued. Quick solutions are expected, where thorough analysis must take place first. The time and effort necessary for innovation is underrated. This leads to disappointment and premature termination of projects. In other instances the responsibility for innovation is placed with the educational research institutes. It should, however, rest with the universities themselves (c.f. van der Klauw and J.J.W.M. Wagemakers, in a paper on "Educational Research and Development at the Universities in the Netherlands").

11. The present largely anachronistic structure of the curriculum may prove strongly resistant to any change in structure, let alone spirit. Furthermore, the main obstacle to implementation of such change is the lack of educators who can cope with the new idea system. Theoretically, full appreciation of the evolutionary idea and process from matter to mind is still shared by the minority of educators. Practically, most educators are unequipped with either indispensible background information, or the theory of organic cultural, cosmic evolution. Specialization prevents most educators from appreciating synthetic overviews. How are they to convey the unity of nature and man if they themselves are largely blind to it? This dilemma cannot be overestimated. Radical educational change depends on the appropriate staff of educators. Yet how can the latter emerge under a conservative educational system? (Eviatar Nevo).

12. Both in the exact and in the approximate sciences, the trend is not towards interdisciplinarity, but rather towards an increase in the number of disciplines. (Mohammed Allal Sinaceur).

13. Thus, the expression 'interdisciplinarity' figures on the agenda of contemporary intellectual life. Unfortunately it is an ill-defined notion, and sometimes seems more like a slogan to be made use of in and out of season in ideological debate. In discussing university reform, everyone stresses the need for multidisciplinarity or pluridisciplinarity in educational institutions; but, according to some experts, all one has to do to form a pluridisciplinary university is to bring together in the same place a faculty of dentistry, an institute of Chinese, and a school of engineering. The unity of learning achieved in this way is merely a unity of accumulation, like a heap of stones. A large number of seminars, conferences, and study groups are no more than assemblies of specialists who, although they sit side by side in the same room, have nothing to say to one another because they lack a common language. The epistemological heart of the *universitas scientiarum* is a void, an empty space separating the learned professors from one another, each turning his back on the others and looking only in the direction which interests him. (Georges Gusdorf).

14. Higher education institutions, particularly traditional ones, have often been called isolated ivory towers. Within them, professors have looked upon their faculties and departments as their own domains; and if their communication with society was limited, so was their communication with other faculties and departments within their institutions. There is evidence that this pattern of isolation is being overcome by the need for communication created by technological and scientific development; yet

> the traditional professor is still rather reluctant to change his pattern and alter his views with respect to courses and their content. This obstacle in traditional universities does not to such an extent affect newer institutions which seem to have a more realistic attitude towards the requirements of society and the need for interdisciplinary approaches. (Edmond Nicolau).

As we saw in the case of Sussex University, to implement interdisciplinary approaches into the university structure may be a difficult task even in new establishments. The Bucharest symposium articulated its unanimous view of the obstacles and difficulties faced in this way:

A. Participants agreed that, presently, the overall structure of institutions of higher education does not favour the development of interdisciplinarity, either at the level of teaching or research. First, there is an educational barrier, notably at the undergraduate level, where students identify themselves with distinct disciplines and professions. Their fields of knowledge tend to be narrowed down, and communication with neighbouring or distant disciplines is not encouraged by curricula or faculty, who do not favour intrusion into their speciality. Even at the post-graduate level, studies often tend to work in the direction of further contribution to the knowledge of one specific discipline. Corresponding socialization again favours conservative, discipline-oriented beheviour. Second, the present departmentalization of universities and the high corresponding degree of isolation constitute a natural obstacle to interdisciplinary communication. Many departments, faculties, institutes, and schools claim to possess a monopoly of expertise, and they look upon outsiders with suspicion. The present rigid organizational structure of universities can be considered as a major obstacle to interdisciplinarity and the eventual creation of new disciplines.

B. The individual achievement pattern, i.e. to seek recognition among colleagues, does not favour team-work, even inside one's department; so far, autonomous, individual academic work seems to be contrary to a truly interdisciplinary mind. Interdisciplinary projects (like publications, thesis, etc.) are rare and not always fully recognized within one's academic community.

C. The present tendency to allocate funds primarily to established and successfully recognized disciplines reproduces the old pattern. Decision-makers are reluctant to make funds available for projects when they do not know what the outcome will be. The growing scarcity of resources, the trend towards accountability, and the use of performance indicators strengthens the tendency to provide funds only for projects and curricula related to traditional disciplines, while innovations, especially in the field of interdisciplinarity, are blocked or obtain insufficient funds. In some countries there are no legal procedures to finance projects of an interdisciplinary nature.

D. Methodological and conceptual differences among sciences do encourage interdisciplinary work; theoretical orientations are sometimes opposed to purely problem-solving, analytical disciplines

and hamper a smooth exchange of knowledge and experiences, notably in the disciplines are of very different nature. Other disciplines, especially certain social sciences, are more descriptive and less predictable, which does not favour their integration into interdisciplinary projects. Here the past emphasis on empirical, descriptive work must be changed by using more predictable methods of work, such as mathematical approaches.

E. There is also an absence of adequate didactic methods for the pursuit of interdisciplinary activities, which in practice may mean that an interdisciplinary team will encounter problems of communication at the language level. Lack of interdisciplinary experience by members of a newly established interdisciplinary team can create problems of isolation and incomprehension. When there is consensus to embark on a given interdisciplinary project, participants frequently encounter difficulties in formulating the right project at the appropriate time (the timing of a project is not always unanimously perceived). Once a project is under way, various problems of behavioural nature may constitute an obstacle: psychological, social, and even cultural constraints, due to the absence of a common language, can bring a project to an early stop.

F. A new mentality ready to accept the potentials of interdisciplinarity does not yet exist; students, faculty, administrators, and even the community persist in hanging onto well-known, well-established disciplines, and all are very reluctant to abandon old patterns and adopt a new mentality.

6. STRATEGIES.

As observed in chapter 5, there are some obstacles and difficulties to overcome before interdisciplinary approaches can become the rule rather than the exception in higher education. According to a statement made by Dr. Per Dalin, Head of Imtec (formerly OECD) at the Gothenburg symposium:[1]

> The complexity inherent in innovation in higher education not only means that achieving mutuality of goals and priorities will be critical to the success of an innovation, but also that new channels of communication, and possibly new management strategies, must be established. Innovation in higher education represents organizational, not technological change, and, innovation in higher education is not something simply to be installed or an easy skill to be learned.

The Chairman at the Bucharest symposium, Professor W. Vosskamp, stressed the vital importance of limiting the complexity of a problem and developing a language for it. In his address he discussed four points which he considered particularly important:

1. Interdisciplinary communication depends on a high degree of open-mindedness and curiosity on the part of teachers and students and an ability to anticipate and welcome new and perhaps surprising ideas.

2. In the tertiary sector, institutions are necessary which, as in interdisciplinary research, scientifically develop study courses in interdisciplinarity. This requires co-operation between scientists and practitioners.

3. Interdisciplinary programs could be taught in the form of team-teaching. On the part of the students, interdisciplinary learning would (without being dilettantish) require a solid knowledge of their field. In view of this, it seems to me that interdisciplinary courses would be practicable only with advanced students.

4. Interdisciplinary courses should, in the future, play a more important role in postgraduate studies. Graduates who have a degree and some professional experience often recognize more easily the possibilities of connections between disciplines and of interdisciplinary exchange between disciplines. I would not regard it as a problem if a major discipline provided the starting-point and other disciplines took on secondary roles to start with. This would represent a first step toward interdisciplinarity.

It is interesting to note that while most experts seem to agree on Dr. Vosskamp's three first points, there seems to be some disagreement with the fourth. One who does not share Dr. Vosskamp's opinion on this point is the Swede Anders Granberg[2] who seems to be quite skeptical of the idea of letting

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1. Op. cit. at the page 69.

2. Anders Granberg, "Tvärvetenskap som ett definitions: och tolkningsproblem," obtainable from FOG, University of Linköping.

one discipline provide a starting point as a first step towards interdisciplinarity. Opinion about whether interdisciplinary approaches should play a more important part in postgraduate studies than undergraduate or graduate studies also seems divided. The Nordic experiences at AUC, RUC, Linköping, and the regional colleges favour the opinion that interdisciplinarity is possible at the undergraduate level too. On the other hand, a French experience suggests that an early introduction of interdisciplinarity is likely to cause methodological confusion in students.[1]

Perhaps this divergence of opinion can be illuminated with the following two illustrations:

A. In principle, there are two approaches to multi- or interdisciplinary education and research. An example of the Graduate Training Program in Biomedical and Clinical Engineering at the University of Belgrad may serve to illustrate those approaches. One is the "hybrid" approach, in which competence is equally divided between engineering and the life sciences; the other is the "team" approach. The main difficulty with the hybrid approach is the length of its training period, which, regardless of whether it is serial or parallel, cannot be shortened to a reasonable duration without sacrificing competence in one of the basic disciplines. Additional difficulties arise from technological or medical obsolescence making it impossible to keep pace with rapid changes and developments in both engineering and life sciences. The primary difficulty with the team approach arises from poor communication between the members of the various disciplines. At the Centre (for Multidisciplinary Studies of the University of Belgrad) the team approach was chosen. Efforts were concentrated on improving communication, and increasing competence in both engineering and life sciences.[2]

B. Another example may throw more light on the dilemma in question. At the workshop arranged for the Working Group on Education and Training in Biophysics at the Unesco Centre (Bucharest, June, 1980), according to the Summary of Discussions, participants agreed that training in biophysics should be a broad education of interdisciplinary character. It was believed that, although many variants would exist with regard to initial higher education, some alternatives were considered more advantageous. One approach was that specialists in physics or chemistry should pursue studies in biology to attain the necessary interdisciplinary knowledge. Another alternative arranged that faculties or departments of biophysics should offer a complete interdisciplinary curriculum.

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1. Frédéric Mauro, op.cit., 1978.
2. Ljubomir Radanovic in "Multidisciplinary Education in Biomedical and Clinical Engineering," A United States-Yugoslav Workshop Report, Dubrovnik, 1977.

In the training of prospective biophysicists, the most important basic subjects are physics, chemistry, and mathematics. In this connection, it was emphasized that the mathematics taught should be basic and not very specialized. Since this basic knowledge most often is applied in biological research, it was felt that interdisciplinarity should occur at the graduate or even postgraduate level.

These examples may serve to indicate that no single approach need be considered valid in all circumstances. The important thing is to derive more experience from an increased number of properly evaluated experimental interdisciplinary projects.

The Central Committee for Norwegian Research is one of the Nordic forums that have engaged in an effort to forward interdisciplinarity. Some of the recommendations made to, or by, this forum may have a general interest and also be fairly representative of the current Nordic situation. Some of these proposals could be summarized as follows:

- A reorganization of university and college departments from a. mainly discipline directed departments to b. also functionally directed and c. system development departments should take place.

- The students should be stimulated to seek elements of their education in all three categories of departments and thus get a broader type of education.

- Great emphasis should be placed on methodical and philosophical subjects. Such courses seem particularly well suiced to close the gaps between disciplines. Examples of subject contents for such purposes could be:

  a. Methodology and scientific theory in areas outside the primary discipline of the individual student.

  b. Social philosophy, general scientific theory, and systems theory.

  c. Planning and organizational theory.

  d. Interdisciplinary environment subjects.

  In Norway the district colleges have made a contribution in this sector through their introduction of interdisciplinary general subjects ("Allmenfag").

- In addition to regular programs for education of researchers and educators, other interdisciplinary post-degree courses could be offered, possibly specially adapted personnel development plans.

- More projects on which researchers or educators from several departments cooperate, on an interdisciplinary basis, could be encouraged.

  When vacancies or new positions occur the possibility of acquiring competent employees should be better exploited.

- Forums for allocation of means to research and development projects should have a policy which is not discriminatory against interdisciplinary projects.

A special example of an interdisciplinary approach was presented at the Bucharest symposium by Professor L.A. Pronin of the Moscow Steel and Alloys Institute (MSAI). The strategy for planning the study process at MSAI takes into account external and internal concepts:

- The external factor has to do with the calculation of the requirements of "social production." This component is reflected at the stage of planning in a speciality qualifications reference document as well as in a testimony of specialists bearing on the elaborated study programs.

- The internal factor takes into account the principles and organization of the study process itself and includes at the planning stage:

  a. The collection of speciality programs for all subjects for the entire training period.

  b. A logical relationships matrix for interconnecting all subject programmes.

  c. Applications for subjects containing additional knowledge.

In his conclusion, Professor Pronin emphasized that the interdisciplinary approach may be regarded as a method allowing the elaboration of thorough speciality study programmes and not programmes for separate subjects as was the case in the past. The approach has appeared to be beneficial, not only at the educational planning stage, but also at the training stage. Availability of the qualification reference documents, the study programmes, and the logical relationships matrix has proved to be of great importance to the instructor. He is allowed the chance to run over the study process for the entire study period by means of the matrix, and he gets a clear idea of logical sequences in the material to be studied.

The familiarization of students with the qualification reference document, the collection of study programmes, and the logical relationships matrix serves to motivate them for cross-section studies and for mastering a given speciality.[1]

It is quite relevant to consider this effort at MSAI as a strong indication of an expressed desire to see the education of engineers incorporated in a multidisciplinary or even interdisciplinary concept. Strategies may vary, however. Even before the Stockholm Conference on International Environmental Education in 1972, Unesco programmes concerning the education

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1. Professors V.A. Romenets and L.A. Pronin, et al. "The Interdisciplinary Approach Used for Drawing up Study Programs at the Moscow Steel and Alloys Institute," (MSAI).

of engineers had pointed to the need for a broader base for engineering education, with greater attention on the social sciences, biology, and the humanities. Engineers were seen as having a universal responsibility for the social and environmental consequences of their technical judgements. At the Stockholm Conference, Recommendation 96 specifically called on:

> The organizations of the UN system, especially Unesco.... to take the necessary steps to establish an international programme in environmental education, interdisciplinary in approach, in school and out of school, encompassing all levels of education and directed towards the general public.

Through a series of important conferences in Paris in 1974 (on Environmental Aspects of Engineering Education and Training), and the first Ministerial level Intergovernmental Conference on Environmental Education in Tbilisi in 1977, and culminating with the International seminar on Interdisciplinary Environmental Education (IEE) in Budapest in 1980, Unesco has gradually improved its strategies in this important field. Participants and others have also had their vision enlarged regarding the environment as a totality: natural and built, ecological, political, economic, technological, social, legislative, cultural, and aesthetic. Similarly, the IEE Programme has stressed the interdisciplinary approach taken by environmental education so as to contribute effectively to the solution and prevention of environmental problems in their multiple aspects. The strategy has included the organization of 25 pilot projects undertaken in all regions by the IEE programme since 1977 and also in the establishment of the Unesco Interdisciplinary Working Group on Environmental Aspects of Engineering Education and Training which held meetings in 1975, 1977, and 1979. Among the workshops arranged, particular importance is associated with the Belgrade Workshop of 1975.

A striking example of the IEE Programme's multiplying effect has been the environmental education training of key education personnel. Through meetings, seminars, workshops, research activities, and pilot projects, a primary group of well over a thousand individuals has been trained in the principles and practice of environmental education. They in turn now train many more.

In the context of strategies, it is particularly noteworthy to follow the progress of the programme studies undertaken by the IEEP. The objective of those studies was to provide teachers with concrete environmental education approaches for their educational practices in the field:

The first study concerns the utilization of modular approaches in environmental education. The study describes, in a general way, the notion of modules and the advantage of their use in incorporating the environmental dimension into regional education programmes. The study also proposes a series of specific modular examples, already applied in different school settings, relating to environmental concerns, such as water conservation, urban environment, health, and nutrition.

The second study relates to the use of gaming and simulation in environmental education. The study describes the fundamentals of gaming and simulation, proposes guidelines for the creation of original games by curriculum developers or teachers, and provides a series of existing, easily conducted games related to environmental concerns, such as conservation of natural resources, anti-pollution measures, urban problems, health and nutrition, and disaster preparedness.

The third study is of particular interest to the current Unesco-CEPES study because it is devoted to the development of approaches, methods, and instruments for evaluating interdisciplinary and problem-oriented environmental education programmes. The study developes fundamentals of evaluation and selected examples, including methods and means of evaluation applicable by teachers in their environmental education activities.

A particularly problematic area recalled from the Stockholm Conference by the writer of the present study was the lack of sufficiently skilled personnel to tackle the complex task of handling interrelations between environmental and social action. A vital part of Unesco's strategy has therefore been to ensure the appropriate training of management personnel.

Another interesting project from a strategic point of view is the interdisciplinary research done within Unesco's Man and the Biosphere Programme (MAB) to develop appropriate training methods for fruitful cooperation among specialists of natural and social sciences. A first experimental seminar was organized on the island of Scopelos, Greece, during 1981, based on research conducted within the project of interdisciplinary study of smaller Mediterranean islands. Now experimental stations have been set up on Skopelos and on three other islands - Gozo (Malta), Salina (Italy), and Kerkennay (Tunisia) - as part of a strategy to train all social groups to participate in the development of the island.

It is their experience that traditional training and re-training methods have not been sufficient to meet new needs. The application of experience gained through educational research efforts to the practical projects here described is therefore strongly recommended. The participants of the previously mentioned Gothenburg Symposium on educational research were keenly aware of this, at least in principle. It would probably be of benefit if the competence revealed through the Unesco sponsored symposium in Bucharest could also be utilized in a more action-oriented context.

Actually what the United Nations has so far done to promote the field of interdisciplinarity could very well be the theme of a separate case study. The fact is that Unesco and the Economic and Social Council and the General Assembly have all been very concerned about the possibilities of finding unified approaches to socio-economic development analysis, planning, and implementation efforts. Several important reports and notes by the Secretary General during the last decade bear witness to this fact.

At the Bucharest Symposium, Ioan Marinescu, Member of the Board of Directors of the International Foundation for Production Research, maintained that interdisciplinarity arises as a function of the development level of a given country, and that it is not an exaggeration to state that it is directly proportional to that level. It follows therefore implicitly that if we develop interdisciplinarity, we contribute to the development of a given society. Perhaps it could be an element of the strategical package to underline this point to the national decision-makers wherever such a strategy may be applicable.

Strategies suitable to influence the decision-makers are of course badly needed. No doubt it is of prime importance to bring about solutions that remunerate leaders who work for flexibility and open attitudes and not for isolationism or sectoral growth at the expense of other sectors. Also in the university sector it should be possible to find arguments and psychological approaches that convince administrators and scientific personnel that undue specialization can be a hindrance rather than a help to a productive development. Perhaps the Japanese concept of "total productivity" could be interpreted in such a way that it became meaningful also in the context of a new university effort.

One strategy is of course to draw as much as possible on the external push impetus. In this very interesting Reference Document for the Bucharest symposium Professor Edmond Nicolau observed:[1]

> In the context of the external push, interdisciplinarity is geared to problem-oriented research and is designated to contribute to the solving of situations or events that are experienced as problems by governments, industry, or society at large. In the last decades, the relationship between scientific research and production has become of utmost importance. Aware of the old adage "knowledge is power," many large industries created their own strong research and development units, and many of the most impressive contemporary advances in a large number of fields are the result of scientific research in such units. Scientific research is thus no longer the activity of only a few scientists in higher education institutions; more important are the interdisciplinary groups of scientists in universities and in industry. The activity in production is being observed by scientists, and a feed-back system continuously fuels new integrated efforts of science and industry. In this connection we must not forget that it is the higher education institutions who must train the professionals for the industrial interdisciplinary activities and for the research undertakings connected with further development in the productive sector. The achievements of contemporary interdisciplinary science offer many examples of how the external push influenced the post-war technical progress. The external push operates in strong interaction with authorities, industry, and universities. The diversification of industrial production, which is mostly interdisciplinary, as well as the continuous appearence of new scientific fields, points out the new tasks confronting higher education.

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1. Op.cit.

Professor Nicolau also very relevantly emphasizes that the rate of obsolescence of knowledge has never been so rapid as at present. As new discoveries require new, and most often interdisciplinary knowledge for development and utilization, it is indeed of great importance that permanent education have a strong interdisciplinary accent. Obviously higher education institutions must offer such education and be aware of the changing demands which continuously require revisions of curricula and content. Nicolau also very aptly underlines that interaction between higher education authorities, administrators, and teachers on one side and the industrial scientific and socio-economic development on the other is indispensible in such a context.

The social demand aspect of the external push can also clearly be utilized to bring about a deeper understanding of the contribution higher education and research can give in providing services to the communities in which they are integrated. As was mentioned in the working document for the CEPES symposium, this service function cannot be enclosed in any existing disciplinary framework. The goal aimed at in this context is to reorganize areas of knowledge and to orient them towards the solution of specific problems. It is therefore a question of providing society with professionals who are capable of studying actual problems and find solutions to them.

Caroline D. Eckhardt maintains in her book[1] that the prospect of accountability suggests that it would be helpful to evaluate the benefits likely to accrue from planned management of change, and the damage likely to result from unplanned change and resistance to change. One must unfortunately share her view that it is not possible to establish costs and benefits in a firm or statistical sense:

> No one would try to prove that a university that actively encouraged change and devoted 3% of its budget to managing it would thereby gain 30% more income from tuition, government allocations, and grants; or that a university that passively discouraged change (by permitting disciplinary self-interest to follow its course) would thereby lose 30% of its income. The situation is clearly far too complicated for any such claim to be convincing.

Nevertheless, and it is hardly difficult to agree with her, she makes the following points related to a strategy for change quite clear:

> New and experimental programs provide a ready mechanism through which to foster desired interchange of knowledge. In a time of general academic retrenchment, it is important to the morale of the faculty - in fact of the entire university - to be able to see evidence of positive change. It may be necessary to accept certain forms of negative change, particularly the reduction of budgets, and it is too easy for all enthusiasm and energy to be lost or channeled wholly into destructive beggar-thy-neighbor political struggles. The existence of an explicit plan to encourage the development of viable new programs and new combinations of

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1. Op.cit.

interests is likely to reintroduce optimism, and thus to have a strongly beneficial effect upon the university's morale.

Because it reveals so much of the particular strategy applied in carrying out an experiment in interdisciplinarity, the Haifa University project also attracts particular attention. Professor Nevo in his symposium paper describes how, in 1976, the University embarked upon a new Honours Undergraduate Prog am, the first of its kind in the institutions of higher learning in Israel. It presented a novel attempt to coordinate disciplines into an integrated inter- and multidisciplinary approach. The program was designed to provide students with the opportunity to study in depth and master one discipline and, in addition, to study a variety of other disciplines according to their choice. An integrative seminar based on the study of specific problems, inter- and multidisciplinarily, meets weekly. Faculty members from a variety of disciplines and a coordinator, whose task is to integrate and synthesize, take part. Students are strictly selected after a personal interview. The criteria for selection of students are distinct and include integrative as well as analytical capacities, intelligence, non-conformism, open- and broad-mindedness, originality and individuality, a keen interest in overviews and problem orientation, and an inquisitive mind. Faculty are also selected along the same lines and provide individual tutors to students on the basis of a mutual interest between the partners. Students are expected to integrate actively in the research studies of their tutors and be in a continuous contact with them.

As of today, about thirty-four faculty members, affiliated with all departments and disciplines of the University, participate actively in the interdisciplinary seminars on three major topics: symbolism, theory and practice, and time. Of the twenty-two graduates since the opening of the programme, fifteen (=68%) are continuing their studies for advanced degrees in their various disciplinary departments. The university accorded the programme high prestige and status and is highly committed to its success.

It is still premature to assess the outcome of the programme. Nevertheless, Professor Nevo states that, of the three major factors responsible for its success, i.e., university commitment and individually selected faculty and students, the last two factors may be substantial in the final assessment, since the commitment of the university is guaranteed.

Finally, the research Institute of Evolution at Haifa University is described as an active partner in the interdisciplinary education offered to students of the Social Sciences and Humanities in order to enrich, expand, and broaden their university education. During the academic year 1981-82, about 750 students affiliated with all twenty-four departments of the University participated in twelve courses and laboratories presented by the principal researchers and assistants of the Institute. These inter-disciplinary courses included "Man in evolutionary perspective: past, present and future," "Evolution and society," "Evolution and behaviour," "Genetics and society," "Ecology and society." These courses conveyed the theoretical and practical contributions of evolutionary biology to human society.

As Professor Nevo rightly underlines, obviously many factors contribute to the fate of interdisciplinary courses. Enthusiasm and experimentation must be founded, not on structural or technical innovations, but on conceptual ones. As long as the idea of interdisciplinarity is not deeply understood, its implementation may fail. However, understanding of the idea cannot in itself guarantee success. The nature, expertise, and devotion of tutorial staff is of paramount importance. Likewise, full institutional recognition of the purpose, structure and value of such courses is indispensible. These courses should not be either marginal or inferior to others; rather, they must be offered at a high level, and accorded the needed prestige, flexibility, resources, institutional commitment, and a favourable climate. Last, but not least, not only the tutorial, but also the participating student body, must be carefully selected and endowed with academic maturity, excellence, and integrative inclinations. The participants must include the best faculty and students who are inclined, at least philosophically, to synthetic overviews. Notwithstanding their integrative inclination, both faculty and students, must also be experts and excellent research workers in specialized fields. They must generalize on the basis of rigour rather than superficiality, said Professor Nevo.

Nevo also made it quite clear that the new approach must dispose of encyclopedic dead wood details and instead must cultivate conceptual thought and the study of ideas, principles, patterns, and processes based on relevant facts. Furthermore he finds it absurd to allot assignments equally to all students. Here, as elsewhere, individual variation and unique personal endowments and interests must be recognized and appreciated. The way to motivate the intellectual potential latent in students is by challenging them with those aspects that are closest and dearest to their hearts and minds. According to professor Nevo, the impossibility of encompassing all knowledge dictates that intellectual progress be gained by securing the appropriate tools rather than by trying to achieve ends which may swiftly become obsolete.

Before closing this chapter on strategies, we should mention a few examples from recent literature on the subject. Unfortunately the scope of this study does not allow further details, but it is to be hoped that the interested reader may still be induced to take advantage of them:

- In order to implement interdisciplinary practices, minimum standards for breadth and maximum standards for depth need to be set up. (Assimpoulos and Belanger, op.cit.)

- Cognitive and experimental learning approaches can provide the student with a bridge acquiring technical skills and applying them in the real world. (Kay Bonnie and Julian Pittman, Engineering-based Interdisciplinary Education for Health Systems Problem Solving, Journal of Allied Health, 1980, No. 2)

- Non-science majors should regard the study of science as an essential part of an undergraduate education. (Labianca and Reeves, op.cit.)

- Mathematics is a science of transfers and analogies of ideas, and, owing to its inherent features, it can establish bridges between all the disciplines. Therefore the potential for interdisciplinarity of mathematics is accounted for, to a large extent, in terms of the capacity of mathematics to serve almost all sciences and, in turn, to depend for its development on stimuli and information deriving from other disciplines. Each discipline is bound to reach a stage in its evolution where recourse to mathematical approaches and language becomes inevitable. Starting with the universality of mathematics in the field of science and with the extension in the application of its methodology in diverse domains of social life (ranging from literature to political decisions), the author advocates the necessity of mathematical education as the basic prerequisite for the development of modern thinking and of an interdisciplinary, holistic, dynamic, and coherent outlook on the part of students. The major idea behind the demonstration of the universality of mathematics is the necessity for an interdisciplinary education relying on the infinite capacities and possibilities of mathematics in this respect, or, to be more precise, the necessity for the increasing development of mathematically based interdisciplinary ways of thinking among the young generation. (Solomon Marcus, The Potential for Interdisciplinarity of Mathematics, Interdisciplinarity in Contemporary Science, Bucharest, 1980, pp. 189-202)

- It is an absolute necessity to reshape the reward system in higher education so as to provide more incentives for teaching or research work in interdisciplinary fields. The need for re-training or further training of academic faculty to acquire more easily an interdisciplinary outlook as well as the respective research and teaching skills should also be emphasized. (William V. Mayville, Interdisciplinarity: The Mutable Paradigm, Washington: ERIC, 1978)

- Team work, transfer of concepts and methodology, rapid circulation of information, the creation of an interdisciplinary language permitting the integration of the achievements in various domains are all indispensible to an interdisciplinary approach. (Virgil Stancovici, op.cit.)

- Interdisciplinarity deals with "many different aspects" in contrast to multidisciplinarity which deals with "many different methods". The strategy should be to get the disciplines to work together rather than to complete with one another. (Maurice Praston, "Some Thoughts on Evaluating Interdisciplinary Research." Higher Education Revue, Warwick: Spring, 1978)

For their part the participants of the CEPES symposium summed up their advice on the more or less unanimously recommended strategies towards interdisciplinarity in the following 10 points:

1. Participants agreed that there are no global strategies for surmounting the above mentioned obstacles, many of which are directly linked to cultural and social attitudes or national policies of organizing higher education. Therefore only a few, general solutions could be envisaged by taking into account that, whatever the scope of interdisciplinarity, it should not be regarded as the panacea for all the problems that besiege society and higher education. Once accepting the inherent limits of interdisciplinarity, one can attempt to propose a limited number of feasible solutions.

2. The best way of convincing hesitant or opposing opinions to adopt interdisciplinarity might be to initiate significant pilot-projects, carefully planned with a sufficient degree of transparency and accessibility to those who could be concerned about trying an interdisciplinary approach.

3. Higher education must be aware that social and community demands upon them (external push) are often of multi-disciplinary nature and can only be solved through an inter-disciplinary approach. Ample participation of users and the community may be very beneficial to the success of problem-oriented interdisciplinary projects. Community participation should also be encouraged in adult education. In this case, an interdisciplinary educational content of problem-oriented character is very relevant.

4. Interdisciplinary undertakings will create specialists capable of extending the scope and possibilities of further experiences in this field. Such persons, trained in one discipline, should be able to accept and understand the terminology and methodology of neighbouring or even contrasting disciplines. A further step later on would be to introduce similar experiences at the postgraduate and then undergraduate levels so as to create a mentality ready to acknowledge the existence of related or complementary disciplines.

5. Some participants thought that interdisciplinarity must be favoured so as to allow the birth of new disciplines, which would imply that, *a priori*, there should be no artificially maintained gap between interdisciplinary research and teaching.

6. It was also agreed that a common methodology and theory pertaining to interdisciplinary research can only be envisioned in a limited number of cases (neighbouring disciplines). However, a certain degree of common language can be found if the project has the necessary resources.

7. There must be more institutionalized encouragement of teachers and researchers to undertake interdisciplinary projects, by rewarding them as in disciplinary projects in the past.

8. Allocation of funds should not discriminate against interdisciplinary projects; in fact, competition for funds must be possible regardless of the nature of the project.

9. Some participants felt that in order to tackle global issues at the teaching level, only interdisciplinary approaches can be efficient. This would require specific manuals, curricula, etc., to provide the necessary teaching base.

10. It seemed that problem-oriented projects based on multi-disciplinary or interdisciplinary approaches have a high degree of success, and their achievements should be made known to a wide public so as to encourage further experiences of this kind. Numerous interdisciplinary projects have taken place but are frequently ignored by scholars and decision-makers. It would be good to make interdisciplinary experiences known at the national and regional level so that a maximum number of users and interested specialists may learn from the experiences of others. Such a regional effort would greatly enhance the prestige, scope, and possibilities of interdisciplinarity.

7. CONCLUSIONS AND RECOMMENDATIONS

In the outline suggested for the present study, Unesco recommended that the final chapter incorporate a futurist view so as to give indications to authorities and institutions of improved approaches to interdisciplinary studies and research. It goes without saying that this is indeed an extremely difficult task, perhaps hardly attainable at all. To a certain degree one might, however, draw on the experiences of the Science Policy Research Unit of the University of Sussex in its World Futures project. In the book Future Worlds by John Gribbin (Plenum Press: New York and London, 1979) seventeen issues are looked at from the perspective of three chosen world-views: a conservative, a reformist, and a radical one. All are related to the quality of life in a high growth egalitarian future world society. Here we find a truly interdisciplinarian and synthesizing effort in which all relevant issues are analyzed and forecasted, in three alternatives. The issues considered are:

1. Geopolitical Issues
2. Political Development and Change
3. Social Stratification, Status, and Power
4. Distribution and Equality of Material Living Standards and Wealth
5. Social Values and Perceptions
6. Action, Order, and Conflict
7. Social Services and Welfare
8. Food and Nutrition
9. Health
10. Work
11. Leisure
12. Education
13. Shelter
14. Transport
15. Energy Issues
16. Materials and Resource Issues
17. Environment

The problem-oriented and action-oriented approach of this project strengthens the impression that it contains some of the "futuristic" qualities sought for in the current chapter.

The CEPES symposium had one comprehensive recommendation to make, which was an unqualified demand that Unesco promote interdisciplinary higher education and research, including dissemination of information with respect to its relevance

and importance to development of contemporary society. In addition as we have seen, the individual participants made valuable conclusive suggestions on strategies. These should be remembered also in a conclusive context, and supplemented by previous recommendations on interdisciplinarity from Unesco and other international forums where these are judged appropriate and relevant. A representative opinion at the Symposium was expressed by Virgil Stancovici, Scientific secretary of the Circle of Interdisciplinary Studies, Bucharest, when he said that:

> We consider it a necessity to introduce the new scientific interdisciplinary spirit at the very beginning of the education process. We may thus proceed to bring up the younger generations by cultivating both an integrated viewpoint of our present scientific knowledge, and - chiefly - an ethical attitude of modesty. We also hope to instill in them the "new mentality," which is mainly characterized by a common language consisting of an interdisciplinary vocabulary, in which each term is defined by the different meanings which can be derived in a range of different scientific disciplines.... Indeed, all interdisciplinary research is conditioned by the actual introduction of an authentic interdisciplinary mind.

Again; a process of education, a common language, a relevance towards society - all are vital preconditions for a needed policy of change. The effort as described by John Gribbin involves multidisciplinary as well as interdisciplinary approaches; but (and this is essential) it also seems to bring them some steps up the ladder towards the higher level of integration called transdisciplinarity. In this sense, the SPRU effort[1] and the Alger approach[2] both contain elements of a foreseen optimistic future for interdisciplinarity. The atmosphere at the CEPES symposium was fairly optimistic, and its recommendations were pragmatic, realistic, and unanimous:

> The participants suggested that, within the framework of the Organization's competence, mandates, and approved programme, Unesco should promote interdisciplinary higher education and research, including dissemination of information relevant to the development of contemporary society. CEPES should participate in this work and should plan for a future issue of its Bulletin on the theme of interdisciplinarity.
>
> CEPES should seek information, for wide distribution, regarding examples of interdisciplinary higher education and research appropriate for further promotion of this field. The making and distribution of a film for television, which amply illustrates the advantages of interdisciplinary higher education, was suggested.
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> The possible involvement of Unesco in the initiation of an international journal on interdisciplinary education and research would constitute an important contribution to further promotion of the field.

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1. Ref. p. 51
2. Ref. p. 66

> The participants recommended that the documents and participants' contributions, including the Summary of Discussions from the Symposium, should be utilized in connection with a study on the subject of interdisciplinarity in higher education to be undertaken by CEPES. The study, which should be widely disseminated, was felt of considerable importance to the further development of higher education in Europe.

Indeed, there is still a lot to do, but much has been done! Especially during the last few years, society, faculty, and students have all become increasingly conscious of research and higher education as a resource which should be put to optimal use. Not least in the Nordic countries, individual researchers and faculty have on their own initiative problematisised their own role and the role of the institutions of higher education. Yet, generally speaking, this has probably been done too sporadicly and accidentally. There is probably a demand for a continuous process of evaluation and discussion of relevance. As far as the research effort is concerned, it is estimated that there is a demand for interdisciplinary cooperation in connection with three fourths of the total Norwegian research activity, at least down to the level of cross-disciplinarity. No corresponding estimate exists for the educational programmes. Even the appearance of new universities or university centres (all Nordic countries) and district or regional colleges (Norway) has not radically changed this overall impression.

The last aspect, to which use the achievements of research can be put, attracted particular attention in 1982. During the last week of August, researchers and scientists from all over the world were gathered in Oslo to attend a seminar on Ethics and Science. A very special thing about this convention was that ethical questions and challenges of all disciplines were posed and dealt with, together, in one single context. To Oslo came historians, biologists, economists, mathematicians - the span of the subjects ranged from military research to humaniora. Joseph Needham, the esteemed British researcher of the History of Science, had this to say to the Norwegian newspaper, the Aftenposten (Aug. 25, 1982):

> The great thing about this conference is that it considers all the ethical issues pertaining to science in one single context. In fact, I have reason to congratulate Norway for having managed to bring about such an interdisciplinary mobilization of specialists and problems. It is the first time in history that a conference of this type has been arranged. Other conferences have dealt with research areas one by one and thus discussed the ethical issues within a narrow framework. A whole range of serious ethical challenges present themselves, such as pollution of the environment, use of electronic data processing, biomedicine, atomic power, fetus diagnostics, transplantation, and a hundred and one other difficult matters.

Asked about what he considered to be the central issue of research ethics, professor Needham answered that the key issue is what we shall do about all the choices we are faced with by modern research. Earlier we had much less scientific knowledge, and then we did not have these problems. Now that so many possibilities have turned up, what do we do? These are ethical challenges but they are also connected with political matters.

What we must have as a guiding line is what is best for mankind.

According to Virgil Ttancovici, the idea of interdisciplinarity, which we endeavour to establish, is an "idea-force" of overwhelming importance. Indeed, it has great impact, both upon the current conception of science and upon society. We have only to consider the cosmic missions performed by the Apollo or Soyuz programmes, which have been scientific performances of highest importance. Such achievements have been possible only because of strict interdisciplinary research. They have also very great consequences for society.

One might add, and so they were indeed for man's potential to face the existential challenges posed by the same interdisciplinary idea-force. Mono-disciplinary approaches cannot solve interdisciplinary problems. Neither can they serve to put the new interdisciplinary achievements to good use.

ANNEX I

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